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THE RELATION OF THE RAILWAY TO ITS EMPLOYEES.

By W. H. Canniff.

IN considering the relations of the railway to its employees every thinking person will at once recognize the vast complications which the problem presents. Not only is it necessary to provide for prompt handling of merchandise under every conceivable condition, but such provisions must be made as will insure the safety and comfort of thousands of passengers who use the roads, as well as those of the men employed.

Again, the railway company is known to the communities through which its lines pass only in the persons of its accredited agents, and upon their tact and general bearing must largely depend the esteem in which the company is held, resulting in coöperation or antagonistic relations as the case may be. Not only does this apply to commercial relations, but also to such police regulations as look to the clearing of streets and similar requirements on a long line of railway. How to insure this desired result is one of the most perplexing problems which confront a manager.

It is manifest that good and efficient discipline is a prime factor, of which, to my mind, absolute justice is the foundation principle; and on this basis can the obligation of a railroad company to its employees and to the public be best carried out. It is obvious that, whatever the rules and regulations, their execution depends upon a large number of men surrounded and largely influenced by varying conditions. This being true, it follows that, in the formation of all rules governing the operation of a railway, great care should be exercised to see that they are based on correct principles, neglecting no

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feature which experience has shown to be necessary in an intelligent execution of such rules, and taking into account the various phases which affect human nature as a whole, remembering that those who are to execute the rules are a part and parcel of the human family.

At this point, however, the work has just begun. While to the mind of an intelligent officer the rules or instructions are clear and explicit, he should bear in mind that their execution depends largely upon an equally intelligent comprehending and understanding by those who are to carry them into effect.

When it is realized that an author usually devotes chapters to definition in order to convey exact ideas, it will be admitted that to give correct expression to ideas much thought and study are required, and that those who are to receive the idea must understand the language used for its conveyance. Hence the great necessity for intelligent direction is apparent.

Men who do not have a fairly intelligent idea of what may be termed the general fitness of things are very low down in the scale. Much more plainly than their employers imagine do they see the relation of the order, or instructions, to the work to be done. The nature of their work makes them keen observers in most instances, quick to recognize in the instructions even the slightest defects, or mistakes, or the want of application to the work in hand, which cannot fail to weaken their respect for those who issue them; and, while the mistake may be easily corrected, the effect upon the men remains.

They have the same hopes and fears, aspirations and desires, as other men, and are surely deserving of every consideration when the importance of their work is remembered. That the employee will do more efficient work if his interest and coöperation are secured cannot be controverted, for the evidence is at hand in every walk of life. When fairly balanced, the interests of the railway company are identical with those of the employee, for with good discipline and highly efficient labor the comfort and safety of the public is conserved, the investment is made profitable, and good wages can be maintained. How can this desideratum be achieved?

First: by most painstaking care in the preparation and promulgation of rules and instructions.

Second: by clearly conveying to the employee what is desired, it being his right to know what is expected of him under all circumstances.

Third: by having him understand that the rules are such that, if intelligently executed, they will insure his own well-being, as well as that of the company, and that compliance with them will result in recognition, either in the way of commendation or promotion.

Fourth: by strict attention to matters of discipline, never permitting employees to be suspended or dismissed except for good and sufficient cause,—this to be shown by clearest proof of violation of rules that were fully understood, and such violation to be invariably disciplined, without waiting for the evil consequences which such rules were intended to avoid.

Fifth: by a consistent course of action which will impress upon the employee the fact that it is the earnest purpose of the company to render him exact justice in every instance.

Men entrusted with the care and responsibility of handling a large body of employees widely scattered over an extended territory must have exceptional talent in order to secure the best results. They must fully understand how vast the interests are which are committed to their care, and upon their fidelity and wise direction the welfare of many employees and their families depends.

The first proposition—that great care should be exercised in the preparation of rules and instructions—is certainly of vast importance, owing to the fact that these are, of necessity, the foundation upon which the whole structure is to rest. They must be such as practice and experience have approved. For illustration, in the preparation and adoption of a schedule, affecting, as it does, during its existence, the movement of every train or engine, there is most valuable information to be gained by consulting those employees whose duties bring them in daily contact with the service performed. Thus not only does the management get the benefit of the employee's experience, but the employee is encouraged to study more closely the problems which arise in the service, with a full knowledge that his ideas will receive the consideration they deserve.

Again, much stress must be laid upon the second proposition. Not only must the foundation of the rules or instructions be clear and conclusive to their author, but the rules must be so worded as to convey to the employee the desired meaning; and to this end the employee should be encouraged to promptly make it known if there is anything in his instructions which he does not fully and clearly understand, thus giving him incentive to better comprehend, and confidence to ask for necessary explanation.

The third proposition calls for such wording of the rules as will adequately explain their purpose. Where for various reasons they cannot be so worded, a duty may devolve upon the management to explain the reasons for issuing them. It will be said that this is impracticable, but I do not deem it so. If a well-disciplined and highly efficient corps of men is desired, additional duties will be forced upon the management, as well as upon the men. To give the men a logical

understanding of the rules is not as difficult as it may appear, and the advantage to be gained in the moral effect upon the minds of those who are to execute more than compensate, in my opinion, for the additional care and labor. It obliges the maker of the rule to exercise greater care in its preparation, in order to defend it when questions arise, and leaves the employee no possible excuse for failing to carry out its provisions.

In considering the fourth proposition, we come to what may properly be termed the most vital point of all.

To write an order, or issue instructions, is a simple matter. To secure the desired result is quite another matter; and, even when care has been exercised, and the instructions are based on good and sufficient reasons, a proper execution is difficult to attain.

The science of good government has occupied the minds of able men for centuries, and various methods are proposed in governmental affairs. Legislation in many instances is followed by failure through neglect of the underlying principle that governs all human action, — viz., that man must be held to strict accountability for his actions, in whatever he is required to do. An infraction of nature's law brings inevitably a punishment, mild or severe. It seems, therefore, fair and reasonable that the employee, after assuming his obligations, should be held to a strict accountability, and that a reprimand, suspension, or dismissal should follow an infraction of his instructions. Before inflicting the penalty, however, ample opportunity should be given him to present fully his side of the case, and action deferred until his fault or blamelessness has been clearly shown by good evidence.

After many years' experience, I have yet to see men fail to recognize and acquiesce in decisions arrived at by this method; and still more positive confirmation of its value is found in the remark, made to me by a distinguished railroad manager, that, after thirty years' service in charge of large numbers of men, and during that time having reprimanded, suspended, and dismissed a great many, he could not recall a single instance where such men did not continue to be his friends. What stronger proof could be offered that his relations with the men were governed by justice and fair dealing?

To impress the employee with the fact that justice will be done, as contemplated in proposition five, it is necessary to treat all infractions logically, and to attend closely to those small details which affect his relation to the company. This, for the busy manager, is difficult; and it will be said that, with all this care and attention on the part of the manager, or superintendent, there will be many employees on whom it will have no effect. This is true; but this very method of investigating acts and judging conduct becomes at once the active agent for

ridding the service of such men, while a marked raising of character will be observed in those who are amenable to its influence, so that the efficiency of the service will be improved at both ends, and in a most striking manner, indicating how essential is constant vigilance on the part of the manager to the development of the efficiency which it is aimed to secure.

We must remember the great magnitude of the railway interests, and that nearly the whole of their wonderful development has taken place during the past fifty years. The railway corporation, even more than any other, is of necessity entirely removed from contact with the men, and the managing officer should aim to serve as a link connecting the interests of the men with those of the corporation. Personal contact, even by the manager, is necessarily infrequent and spasmodic, but all the advantages of personal contact can be secured by the just and impartial review of questions which arise between the men and subordinate officers. While the decisions thus rendered can serve as precedents for the determination of similar questions as they again arise, in this manner also the caprice of judgment shown in passing on similar offences on separate portions of the line can be corrected, and all divisions be brought to act in unison, this uniformity of action forming an essential part of that justice which is deemed essential to good discipline.

The public are daily becoming more exacting, and of necessity the railways must meet the changed conditions. The older employees must of necessity adapt themselves to the new order of things, which means, in many instances, a change in the habits and practices of years. This can best be accomplished by appealing to their reason, as indicated above, and gradually bringing them to act from proper motives, through conviction that good results will be attained thereby.

As one illustration of the effect of appealing to men's understanding, I will cite the following :

It became necessary to change the location of a division terminal, in consequence of which the runs of one end were made much shorter than those of the other. Soon after, the men making the shorter runs demanded the same remuneration that they had received for the mileage formerly made, although the men on the longer runs, under the new arrangement, did this work, and received the pay for it. It was claimed that the division time-cards had not been changed, and the men insisted that the time card distance should rule. Answer was made that their request would be granted, and they must decide for themselves whether the time-card distance or the actual distance run should govern. The time-card distance was at first decided upon : but, when it was shown that, if the time-card distance governed in the

one case, it must also govern in the other,—that, if the men of one division received pay for thirty miles which they did not run, the men on the other division, under the same rule, would run thirty miles without receiving any pay for the same,—the men reconsidered their request, their acquiescence to the existing arrangement being given in such a manner as to leave no doubt of their conviction of its justice.

To show the force of emulation, I may state that, while in charge of a track division comprising fifteen sections, each under a foreman, I have repeatedly instructed seven of the foremen to perform work at the ends of their sections tending to materially improve the condition and appearance. In no single instance did I fail to find the eight alternate foremen doing the same work not later than the second day, although no instructions whatever had been given them, the contrast and improved appearance of the adjoining section impelling them to similar action. In this manner the men are mentally and morally strengthened, while the quality of their service is much improved.

The apprentice who enters the railway machine-shop with proper qualifications for success will in good time become a master workman, capable of directing the building of a modern locomotive. Such men, taken as a class, will be men of fixed ideas and purpose. Their work has been of that nature which requires exactness in every detail, performed under the watchful care and within reach of the helping hand of a resident official.

To place such a man in charge of the machine he has built, which, in its frequent trips by night and day, surrounds him constantly with uncertainties, calling for exercise of individual judgment and the faithful discharge of duty in the absence of all personal supervision, is to absolutely change his environment, and consequently his ideas and inclinations; and, although the same person, yet he is in an entirely different class, requiring different treatment, all of which should and will be considered by the intelligent officer. In other words, the latter will recognize the plain distinction between employees whose duties tend to fixed results, and those whose duties are full of uncertainties, as in train service.

Absolute frankness upon the part of those in authority, when dealing with the men, forms an essential part of the relations which the railway company should bear to its employees. If requests are made which cannot consistently be granted, it should be answered that such is the case, it being far better that the employee should be disappointed at the time rather than suffered to entertain hopes not to be realized in the future.

In many instances promises of promotion are made with an un-

doubted intention to fulfil them ; and yet, as every officer knows, circumstances over which he has no control arise to prevent the fulfilment. Not only are such failures disappointing to the parties directly interested, but they involve a lowering of confidence in the minds of the employees in general, which must tend to weaken discipline, however slightly. As no explanation can change these feelings, avoidance of promises is the wiser course.

In the acceptance of new men for the various branches of the service, it is of advantage to the company, and positively due to the men already employed, that the existing standard of efficiency should be maintained. To this end suitable references should be required, with the understanding that the applicants will not be employed until such references have been looked into, and assurances received that the applicant is worthy in character and gives evidence of capacity, as only by such discriminative methods can justice be done to the employees whose capacity has been proved.

In the relations of the railway to the employee, it is the part of wisdom for the railway officer, when positions become vacant, to promote, whenever possible, some one of the employees already in service. It is true that in the strict sense the obligation of the company to the employee ceases when the stipulated sum has been paid him for the service rendered ; it is equally true that with the performance of a fair month's work the employee has discharged his full duty ; but, as we seek to increase the efficiency of the service, evidences of unusual loyalty and energetic performance of duty should be met with due recognition by promotion to such positions as call for the exercise of the qualities displayed.

What more powerful incentive can be placed before men than the feeling that in due time faithful service will be recognized, and promotion be reasonably certain ? An employee, in answer to my question as to how long he had been a freight-brakeman, replied :

"Seven years."

"Are you not getting discouraged ?"

"Oh, no," said he, "I know my time will come pretty soon, if I do my duty."

This kind of incentive is constantly felt, and must exert a more powerful influence than any other ; and the feeling is not confined to employees.

Since the improvement of the men is an advantage to the service, there is much to be gained by railway companies in taking an interest, and aiding pecuniarily, in the provision of suitable quarters at principal points where employees can spend their leisure hours surrounded by good influences. In this way the Young Men's Christian Associa-

tions have rendered valuable service, and it is a pleasure to note the rapidly-increasing interest shown in this direction by many railway officials, and the appreciation of such efforts by the employees, as evidenced by increasing attendance and interest, thus conclusively proving the good results upon men when they become impressed with the evidence of concern for their personal welfare.

Thus it is that we find large numbers of men engaged in an occupation the nature of which requires keen perception and close adherence to fixed rules. Any failure on their part may result in loss of property or danger to human life,—a most exacting service; yet, considering the interests involved in the movement of freight and passenger trains, how faithfully their service is performed! But success in this as in any other form of government can only come with close study and constant watchfulness.

The relations of the railway to the employee being impersonal, the manager must in his own person fill the void. The employee is, in a great measure, what the manager's conduct makes him. If the manager desires an interest in the work aroused, he must show an interest in the men. When strict and intelligent obedience to the rules is demanded, the manager must not shrink from a strict and intelligible construction of them. If he wants the employees to fearlessly discharge their duties, he must as firmly uphold them where no blame is shown.

When more than usual zeal is manifested, promotion is a wise means of proving appreciation. Wisdom in judgment will command respect, honesty of purpose will win confidence; and, when these reciprocal obligations are recognized and performed, the relations of each to each will be better understood, a more friendly feeling will arise, fewer strikes will prevail, and, in the determination of the honest differences which may arise, the convictions of reason will prove a more potent factor than coercive force.

RELATIONS OF THE EMPLOYEE TO THE RAILROAD.

By Cy Warman.

AS the shifting sands in the bed of a river are constantly changing the channel, so are the conditions of the country constantly changing the relations of the railroad employee to the railroad.

When the country is prosperous and all the railroads are running full-handed, employees are apt to air their grievances and ask for a raise in wages as often as a dividend is declared. When times are hard and hundreds of idle men are abroad in the land and locomotives are rusting in the round-houses, railway managers are apt to ask the employees to submit to a reduction in wages as often as a fresh batch of men are discharged and sent adrift. These facts may not be very complimentary to either side, but they are facts, I fancy, all the same.

The railroad company proper is regarded by the average employee as a mythical soulless something, ever invisible and always out of reach. The struggle is really between the men and the management, the employees and the officials; and, as they are all employees,—from the president to the tie-tamper; from the master-mechanic to the poorly-paid wiper,—we must have a division to begin with. Out of this great body we must find the fighting forces for two armies, absurdly arrayed: one under the flag of "Capital," the other bearing the banner of "Labor."

This condition of things is all the more inconsistent when we remember that the real fighters are all laborers; only, one side has succeeded, the other is struggling to succeed. And how are we to know them? When does the "employee" become an official? Ah! that's the easiest thing in the world. For example, this change in the life of a locomotive-engineer comes the day he is promoted to be travelling engineer, or round-house foreman. It comes to the conductor when he is made superintendent of a division; to the telegrapher when he becomes a dispatcher or train-master. The other employees come in awkwardly, congratulate the new official, and then go back to the boarding-house and lock their trunks. Here is a parting of ways. From this day the new official walks on the other side of the street, regarding the promotion (for which all are striving) almost a misfortune. At the end of a week his room-mate leaves him, and he goes also,—to live in a better place. At the end of a fortnight he finds

that he has, almost unconsciously, changed his mode of living and his associates.

He sits no longer in the councils of employees, for he stands for the company,—for Capital. In many cases he pays up his dues and takes an honorary membership, or withdraws finally from the Brotherhood. He is so different in his new place that sometimes he is accused of being "stuck on himself." I put it that way, for it is precisely as the "other fellows" will put it; and I have dwelt upon this point to show that there is no mistaking an employee for the "company," which is simply the management. It would not be just to say that the new-made officer deserves all the bad things said of him, nor would it be right to say that the unpromoted employees are wholly to blame. They have simply all dropped down the wrong leg of the "Y," and nobody has taken the trouble to back them up and set them right. Then it is always so much easier to convince a workingman that he is getting the worst of it than to show him that he is prosperous and ought to be happy. That's why the professional agitator has such smooth sailing. Man is a scrappy animal at best, and I think that the constant strain under which the railroad employee works tends to make him especially irritable, as the constant watchfulness of his nature tends to make him suspicious of signals which are not perfectly plain to him.

The railroad manager at his office, dictating letters, directing business, and hearing grievances, is a different man altogether when seen at the club, at the races, in Sunday-school, or at home; but the less experienced employee is always the same on and off duty. He has not yet learned how to forget his work,—to put it aside, and rest his weary brain. He railroads, not only earnestly, but all the time: on the rail, in the round-house, the barber-shop, and the boarding-house. When he wants his plate changed, he tells the waiter to "switch out the empty and throw in a load."

The little jealousies and animosities just described exist among the employees as well as between the man and the managers. For years the bitterest hatred existed between the members of the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen. Until lately a member of the latter organization was not eligible to membership in the former. In the West, where promotion comes quick and easy; where the fireman of to-day is the engineer of to-morrow; where the world seems wider and ideas broaden,—these narrow views found little favor. Indeed, it was the Western delegates in the convention who caused these restrictions to be removed.

There existed for years the bitterest hatred between the members of the Order of Railway Conductors and the Engineers' Brotherhood.

So cordially did they hate each other that it was almost impossible to get good service. Railway managers made no frantic effort to bring about a reconciliation between these important branches of the train service. On the contrary, I am afraid some of them rejoiced in the strife, knowing well that so long as labor warred with labor, capital would have smooth sailing.

When the Knights of Labor were in their glory, many railroad employees turned to that organization as the coming Moses. This led up to a struggle between the Knights and the Brotherhoods.

When Debs—often wrong, but always honest and earnest, I believe—conceived the idea of bringing all railroad employees together in one colossal Brotherhood, he found himself opposed by all the older organizations, including the Brotherhood of Locomotive Firemen, for whose advancement he had spent the best years of his life. Just as the different nations of the earth train their cocked cannons on the other shore, so do the various labor organizations of the United States lay for one another.

Happily, thoughtful men are beginning to regard all this as quite unnecessary, as a great waste of energy, and a change is coming. Looking back over the fields where labor and capital have fought, we see only waste, want, desolation, and death. In struggles of this kind capital gains nothing, and the best labor can get is the worst of it. The great strikes of the past twenty years, including the last bitter struggle of 1894, must prove plainly to the thoughtful workingman that he must rely mainly upon his own ability to make a place for himself in the world and to hold it.

The struggle between the American Railway Union and Mr. Pullman in the beginning, the railway companies of the country in the end, have proven two facts: to capital, that it is just as well to treat fairly and deal honestly with labor; to labor, that the country is not ready for anarchy. Few people believe that the acts of lawlessness committed at Chicago were the doings of workingmen. These outrages were committed mainly by idle loafers and criminals of every cast and from every country. Foreign workingmen, at best, appear to bring all their grievances, all their disrespect for law,—in short, all they possess that is un-American,—to America. In nearly all the labor disturbances the finger-marks of the foreigner are plainly visible. The long and lawless struggle at Cripple Creek was organized and officered wholly by foreigners, and their energies were directed mainly against one American,—self-made, so far as his fortune is concerned,—who, in the panicky winter of 1893-4, advanced nearly $100,000 to build a railroad to the great gold camp, thereby providing work for hundreds of men who were actually hungry. I find no fault with a

man because he is a foreigner ; only, if he cares to live in the United States, he ought to respect the laws of the country. But, when an American journal, or news-gathering association, will interview an Anarchist upon the murder of the president of a republic, allowing him to rejoice in cold type over the death of a distinguished citizen of another country ; then, when Americans allow such a man (a murderer at heart) to live in the land,—Uncle Sam becomes an accessory, and by his tolerance encourages Anarchy.

I have seen their emblems. Here, in Paris, not more than a mile from where I write, there is a corner in the grave-yard set apart for these miserable people. The walls are all ablaze with red rings, a sort of bloody funeral harness, and on their shields, red with rust, are engraved the knife, the pistol, and the torch. It is not good for the young republic of France, with a new-made grave of a murdered president, to allow these things to hang here with their breath of danger and hints of death.

It is not difficult for one, even slightly acquainted with the history of the railroads of the United States, to pick out those that have been most prosperous ; and it is gratifying to note that those roads enjoying the greatest prosperity are generally at peace with their employees.

We have seen the unpleasant side of the employee,—how, in the past, peace seemed to trouble his mind,—and now we shall see the other side.

He is not only capable of appreciating humane treatment, but is as loyal to the company employing him, when properly handled, as the highest officer can possibly be. Cross him, and he will fight for his manager. Ask his opinion, and he will show you how far the "Thunderbird" of his line is ahead of the wretched and rickety old "Nighthawk" run by the opposition road. The enthusiasm of the earnest and industrious passenger-agent and his army of assistants seems to find its way down the line to the humblest employee.

I don't pretend to say that such is always the case. A great deal —nearly everything, in fact—depends upon the character of the higher officials. A railway manager the fingers of whose 'phone run down to the pool-rooms and the gilded palaces of painted women will have a demoralizing influence upon the employees of the road. Turning restlessly in his office-chair, ever gazing out at the window to fields which he fancies elysium, ever impatient and anxious to get away from work, to return to play, he cuts everything short, and you will find his subordinates following in his footsteps.

Take the manager who is thoroughly in earnest, honest, and loyal to the company, and his influence will be felt. It is not difficult for a manager to win and hold the respect of the employees of a railway. If

he but takes the trouble, and has the happy faculty of imparting a little human kindness to every employee with whom he comes in contact, he will soon win the respect of all his subordinates. In doing this he makes his own labors lighter, and at the same time adds to the happiness of the employees and the revenue of the road. The best service can be had only when all work harmoniously and with a will. Railway employees know when they are treated decently. They know, too, that an impartial judge, commonly known as "public opinion," will pass upon their cause, and they are learning rapidly that it is not good to kick unless they have a "kick comin'," as they express it. The best of them are not great readers, but they manage to acquire more knowledge of things in general, and railroads in particular, than the average citizen does. Go and mingle with a band of yard-men who are loafing round a switch-engine, and in a half hour you will get a good bit of the history of American railroads and much of the personal history of the leading railway officials of the country. You will find, too, that, if they "roast" some of them vigorously, they praise others enthusiastically. It is always pleasant to say nice things of other people. It is pleasant to try to pick out the good things in the life of a man whom the public has regarded as bad. Jay Gould, for example. The employees of railroads commonly known as the "Gould Systems" were always sure of three things,—good wages, decent treatment, and a good check for their money the moment they earned it. This respectful consideration for his employees, which was one of the noble traits in Mr. Gould's character, has been imparted to his assistants, and is distinguishable to this day. Not long ago, during an inquiry by the government into the matter of wages of employees, the president of one of these roads was called to the stand to testify. When the venerable railroader took his place and raised his hand to be sworn, his white hair falling like a halo about his head, the United States judge looked at him for a moment, and said: "You needn't swear." Perhaps the judge remembered that in that same city—then a wild out-post of civilization on the Western plains—this man had begun his railroad career as a humble employee, and that in all these years his honesty had never been questioned, and that was sufficient.

Perhaps it was not much to take his testimony without swearing him, but to me it seems a delicate and touching compliment to this great good man. I know it is customary to preserve these little flowers for the grave, but I prefer to put this one here. It may serve as a "marker" to those who follow in his footsteps; a something to strive for; "a consummation devoutly to be sought."

I never knew Tom Potter,—never saw him,—but I know he lived

and died. I remember that for a year after his death it was impossible to open one of the many trade magazines, printed and supported by railway employees, without reading a line like this: "Send something to the Potter Monument Fund." I do not know that he ever got the monument, but I know he got its equivalent,—a monument of devotion, which can only be built on the foundation prepared for it in life. It proves that in the average railroad employee there is a pay-streak of gratitude, and that ought to make up for a multitude of shortcomings. But it is not necessary to die in order to receive his respect. During the hard times in the West, caused mainly by the closing of the silver mines, a very conscientious general manager called a number of employees together to discuss the matter of a reduction of wages. There were present representatives from the various brotherhoods and labor organizations who had been sent to head-quarters instructed to submit to no reduction of wages. The manager made his case so clear—showing the delegates the utter impossibility of keeping all the trains then on the time-card running, and the folly of supposing that the owners of the road would retain him as manager unless he made some effort to reduce operating expenses to fit in a measure the decrease and still decreasing earnings—that he at once won the respect of the delegation. When these poor fellows returned to their several homes and made the result of their deliberations known, there was a great row. Some of the more ignorant and unscrupulous employees openly accused the delegates of selling their constituency to the railroad. The manager heard all this in due time, and, having faith in the justice of his cause and the humanity of man, he submitted the question to a vote of all employees, with the promise that wages would be restored at the beginning of the following year. The men voted to submit to the proposed reduction, but few of them ever knew what want and misery they saved by so doing; for, if the manager had been beaten, the force was to have been reduced, and thus many of them would have been thrown out of work entirely at the beginning of a hard winter, when all the railroads in the country were discharging men.

A less thoughtful, a less humane manager, would have ordered the reduction in wages which circumstances certainly made necessary, and created a strike,—won in the end, at the expense both of the employees and of the stock-holders. It is well to observe these things and the way they work. They all show that a straightforward, open, and honest policy will often save money for the people who have been enterprising enough to build railroads, and prevent the less learned employees—the fretful children of the rail—from running blindly into danger.

I happened to be in San Francisco when Mr. Stanford died, and I

want to say a word for him. If you ask me how he managed to save twenty millions in twenty years, I cannot answer; but there was something good and gentle in his nature. Poor Mr. Stanford! Surrounded as he was with his miserable millions, with all his wretched riches, yet his going away was as peaceful and pathetic as the death of a nun. He knew, it seems, that he was going, and had selected his pall-bearers. They were the six oldest locomotive-engineers in the employ of the company. Many times he had placed his life in their hands, and now at the end he wanted these strong, brave fellows to "handle his train" on the last sad run. As usual, they did their work well, walking upright with a firm step. Their eyes were tearless, their faces calm, but, if you looked closely, you would see them trying to swallow something. It was that hurt in the throat that comes to men —unfortunate men—who are not weak enough to weep.

At the other end of the procession another band of employees walked with bowed heads and tear-wet eyes. Men whose homes and gods were at the other end of the earth, who found the paths at the Occident slippery ways; but they had taken something of the tenderness of their gentle master, and so walked in his wake and wept.

RECENT ARCHITECTURE IN FRANCE.

By Barr Ferree.

NO study of modern French architecture can be undertaken that does not, at the outset, acknowledge the paramount position of the School of Fine Arts in its development. The two are so closely connected that the one cannot be considered without the other. The history of modern architecture in France is, in truth, the history of the School and its teachings. The School of Fine Arts in Paris has now been doing business for nearly two hundred years. It is a respectable period of time in any country, and in France it is equivalent to many ages, if one counts by governments, since in this period more styles and forms of government have been set up in Paris, and knocked down and reset up, than the average man likes to think of, or even can keep track of. Yet through all this political turmoil the School of Fine Arts retained its individuality and spread abroad its influence, until, lo! not France alone salutes it as supreme, but every civilized land.

There was once a time, and in French history to boot, when two hundred years would have stood for gigantic strides in art. A little more than a quarter of this time sufficed, as far back as the end of the twelfth century and the first half of the thirteenth, to dot the upper provinces of France with the most glorious edifices human hands have consecrated to divine purposes; and that, not in a single form of art, guided by one rule, limited by one standard, but in a living, vigorous art scarce more than indicated at the beginning of the period, and in the full flower of maturity at the end. It is, perhaps, scarcely fair to demand that, if French architecture produced so great a growth in one short sixty years, something kindred to this development might be looked for in a later period of nearly four times that length. It would be a grand thing and a wonderful one if it could be so, but the epoch covered by the history of the School of Fine Arts offers few points in common with the marvellous age of Philippe-Auguste. The older time witnessed the evolution of a superb architecture, not because for sixty years the master-builders of the age were intent upon a single idea and labored only with a single set of forms, but because the time was ripe for architectural development. Nothing of the sort has marked the period of the School's history. People had learned to think of other things than art; art itself had changed its form and aspect; manners, customs, ways of living and thinking, even the trouble of setting up new governments only to knock them down again, kept people's minds

SCHOOL OF FINE ARTS AND CITY LIBRARY, MARSEILLES.

M. Espérandieu, Architect.

HOTEL DE VILLE, POITIERS.
M. Guérinaud, Architect.

so far from art that during much of that time the greater wonder is, not that so little was done, but anything at all.

Certainly this may be said of the first hundred years, or slightly more, of the School's existence. But its position to-day is very different from the place it has previously occupied. Never before was its influence so wide, never before were its votaries so numerous, never before were its opportunities so great and so far-reaching. Had the object of its founder been to dominate the world in architecture, it might be said that at last it has obtained the place for which it was created. It does not, indeed, reign supreme; its forms are not always imitated by its followers; the whole earth is not yet filled with designs turned out in its *ateliers;* but its present position is at once so commanding, its influence so widespread, and its example so numerously followed, that the fact of its supremacy cannot be questioned.

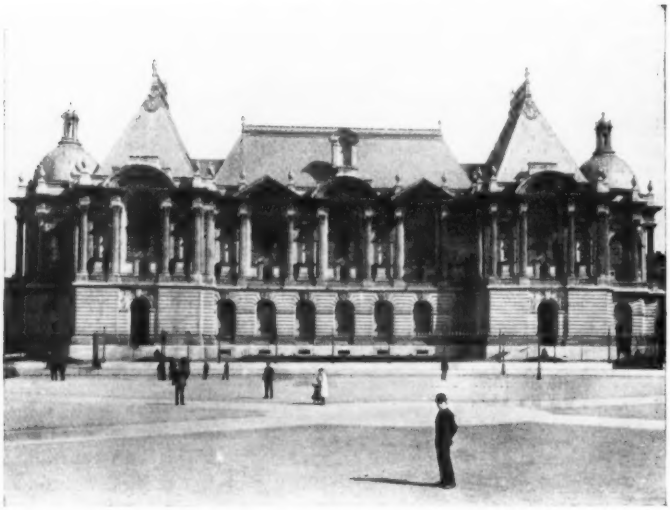
It is high time the question were asked: What are the grounds on which the School's pretensions to supremacy in architecture exist? That this supremacy is claimed; that to a certain extent it exists, since followers and imitators of the School's forms are to be found in every land,—cannot be denied. The question is not whether such a supremacy exists or not, whether it is wise or not, whether it is something we should admire or not, but what are the grounds on which it rests? Although, in the two hundred years of its existence the School of Fine Arts has not produced an architecture comparable with that developed in the reign of Philippe-Auguste, it has not been idle. Buildings of one sort or another have been built in France with quite as much frequency during its history as in any corresponding period.

The new demands of a later civilization have modified to some extent the nature of its products, but it has calmly met every problem submitted to it for solution; deliberately, if not always wisely, applied its stock features of balconies, pilasters, framed windows, and cornices to these problems; and then called upon the civilized world to admire the results. These have not been few; yet its work has consisted in but two things: in the making of designs for buildings never intended to be erected, in the solving of problems never occurring in actual practice, in the putting of lofty dreams and elaborate masterpieces upon paper; and, on the other hand, in erecting a certain number of actual structures of more or less interest. The former constitutes the actual educational work of the School; the latter forms the life-work of its pupils, and is the fruit by which it is to be judged, the end for which it has been brought into existence.

The School must stand or fall by its results and its works. That its paper designs are grander than its constructions in brick and iron and stone, and that the conceptions of the student are more sublime than the actual buildings of the architect, is perhaps not to be avoided. Pleasant dreams are apt to be pleasanter than the most delightful of earth's realities, and, if an architectural system is founded on the dream basis, it need not be wondered that its fancy flights should possess points of interest not to be seen in stern realities.

The inquiring student from America who seeks to study French architecture in its own fair land must be impressed from the very first with the extraordinary fact that it is the bad elements of the School's work that are imported by our Franco-American architects, — Frenchites is a better word, —while it is the good

THEATRE DE LA RENAISSANCE, PARIS.
M. Carrier-Bellerise, Architect.



THE PALACE OF THE FINE ARTS, LILLE.
MM. Bérard & Delmas, Architects.

points that are generally ignored. Exceptions there are to both these statements; yet I have been time and again impressed with many excellent features in current French work of which we scarcely hear anything in America, and certainly see nothing at all. In other words, the first lesson the student learns is that America is the worst place in the world to study French architecture, notwithstanding the fact that a large number of able architects will confidentially inform you that no man at home is worthy the name of architect unless he has studied in Paris, and the further fact that the copying of French forms, the aping of French ideas, the reproduction of French models, now amounts to an actual craze with us.

The most distinguishing characteristic in current French architecture, the element that may be seen in almost every building, the quality that may be noted in every locality, is the adaptability of the structure to its purpose. If it is a school building, it is a school and nothing more. If it is a town hall, it is as unmistakably that, and is as elaborate a piece of architecture as the appropriation made for it permits. If it is a great palace or an expensive museum, it partakes of the natural character of these structures. In business buildings alone is this nice balance sometimes lacking. If funds are short, the building is correspondingly simple; if they are ample, it is correspondingly

THE NORTHERN RAILWAY STATION, PARIS.

M. Hitorff, Architect.

BOURSE DE COMMERCE, PARIS.
M. Blondel, Architect.

rich. There is always a careful adjustment between funds and purpose and architecture that the people of other lands would do well to ponder over and profit by. Those American institutions—and several might be named—that have projected costly palaces for themselves with only a fraction of the necessary funds in hand are proceeding upon a principle of economics in architecture that no Frenchman would venture upon. But this is one of those common-sense pro-

HOTEL DU LOUVRE, RUE NOAILLES, MARSEILLES.

cedures in French architecture that our importers of that commodity have as yet failed to bring over.

The results of this common-sense policy are just what might be expected. The Frenchman does not build for show, unless he is able to carry out his project. He is never afraid to build simply and plainly; nor does he hesitate to satisfy himself with a plain wall, —though he will go so far as to whitewash it,—if that is all his money will permit him to do. Architectural art often loses by this

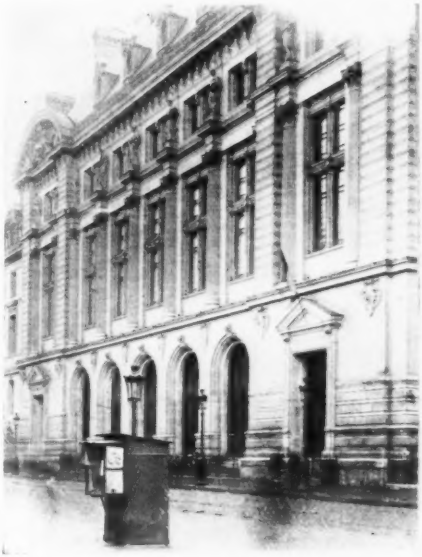
CENTRAL SCHOOL OF ARTS AND MANUFACTURES, PARIS.
MM. Deniimuid & Denfer, Architects.

habit, but there can be no doubt that the French people are gainers by it. Examples of this may be seen in almost every city and town in France. The schools, of which a prodigious number have been built, are excellent types of it. Plain, simple, unpretentious, almost ugly buildings in their absolute want of artistic form, these well-planned, conventionally-designed edifices must, for all their lack of pretence, be counted among the most important and successful of modern French buildings. For, plain though they be, it is not slipshod building that they illustrate, though in America they might be spurned by the average architect and ignored by the best as beneath the notice of masters of their art. These plain walls, these severe forms, are part of the system on which the buildings are designed. Intended only as coverings and housings for the schools, it matters little what their external form may be, if their planning is judicious, economical, and wise. That is the real strength of these buildings; their façades are nothing, their plan is everything.

There is much wisdom in such a system, but it is not applicable to every sort of structure. A plan is not a building, though it is a good start and an essential foundation. But, if modern French architecture had nothing to offer but these formless schools and kindred buildings, the system under which they are produced would soon topple off its lofty perch on the apex of architectural art in the nineteenth century. We may regard the absence of architectural features as admirable in buildings where their presence would be a superfluity or where the funds in hand will not permit their use, but we require more than a plan to satisfy our conception of modern architecture as an art. Yet the disdain

with which the elevation is frequently treated in these elementary structures sometimes appears in more pretentious works, for in these too frequently the façade fails to equal the plan in excellence, and students at the School make no secret of the fact that the larger part of their time is given to the study of the plan, the elevation being left until the last, when it is, as it were, pitchforked upon paper and regarded, apparently, as the product of inspiration rather than as the result of profound study and careful thought.

If one sees many buildings in France that interest only by their severe insistence on commercial or financial requirements,—and these are not what we call commercial buildings in America, but schools, manufacturing establishments, and the like,—one is not less astonished by the prevalence of bad buildings. For one masterpiece there are a thousand horrors,—a truly extraordinary state of things for a country which not only affects to lead the world in art, but which supports a great school of architecture for the creation, maintenance, and preservation of an architectural standard. We may look upon such a condition at home with a certain equanimity, since we can always console ourselves with the thought that we know no better. But France! Surely, if anything is admitted in modern art, it is that they do things better in France than in less enlightened countries. And yet, if all the pretentious buildings erected in France in the last twenty years could be gathered in one single exhibition,—barring such extraordinary masterpieces as the Opera House in Paris, the Palais de Longchamp at Marseilles, and one or two similarly ornate structures built under unusual circumstances,—the proportion of interesting buildings to bad, of good things to indifferent, would be found



THE NEW SORBORNE, PARIS.
M. Nénot, Architect.

very small indeed. That this is actually so cannot, I think, be denied. That it is so relatively leads to but one conclusion,— the failure and incompetency of the School of Fine Arts to introduce an architectural standard that its pupils can carry into actual practice.

Suppose, in the list of buildings that might be considered, above the average, both by purpose and in cost, there were fifty or even a hundred ; what would that be out of the enormous total of other structures erected in the same period? Look at the conditions that surround architecture in France. Elevated to the dignity of a department of the government ; given a costly and superbly equipped School for the training of young architects ; provided with every apparatus, given every opportunity, dowered with prizes and rich collections,—architecture enjoys opportunities in France that it has in no other land. And when to this we add the natural artistic tastes of the French people, their rich artistic past, their countless artistic monuments, their environment, their skill, their ingenuity, in very truth it would seem that the production of architectural masterpieces would be an everyday occurrence with them, while no trouble at all should be experienced in giving less pretentious structures that grace and beauty they could not have in less happily situated lands. Is it too much to ask for this? Is it too much to look for extraordinary things when men, after all, are but human, and accustomed to mediocrity?

STREET ARCHITECTURE IN MARSEILLES.—THE BARTHOLDI FOUNTAIN.

THE PREFECTURE, POITIERS, COURT FRONT.
M. Guérinaud, Architect.

Unquestionably it is too much to insist on masterpieces as the solitary product of the School of Fine Arts. Doubtless it would be both delightful and elevating if such were the truth; but the history of architecture—and the history of French architecture is not an exception—shows that masterpieces are the rare gems, not common, every-day affairs. It is true this rule was all but broken during the great cathedral-building epoch in the thirteenth century, and again when the valley of the Loire was dotted with its châteaux, but those were exceptional times that have no counterpart in the present day. And it is further true that the educational work of the School is chiefly concerned with the making of masterpieces on paper, and it might, perhaps, be in order to ask that some of this skill, so abundant and so plentiful in student days, should be served up in appreciable quantities in real structures. But, while it may be true from the French standpoint that all its architects are capable of producing masterpieces, very few of them, with the opportunities of producing great buildings that occur more frequently in France than elsewhere, ever actually have the chance of doing something really great. The most they can do is something good; and it is by this they should be judged.

Did time and space permit, it would be interesting to interrupt this discussion for a little dissertation on the geographical distribution of modern architectural monuments in France. If architecture is so important an art in France that the government can support a costly school for instruction in it, there must be ample opportunities for its graduates to build and cover their land with buildings both interesting and good. Yet I have been solemnly assured by gentlemen who have made their life-work the diffusion of architectural knowledge in accordance with the French standard that it is only in Paris that notable works in architecture are to be looked for. Is it true? I trust not; I do not think so; but at least this statement reflects culti-

PRIVATE RESIDENCE, AVENUE BOIS DE BOULOGNE, PARIS.

vated and trained opinion on the subject, and saves one the bother of visiting the Departments in search of modern architecture. But let us, for the nonce, accept it as fact, and study the monotonous streets of Paris.

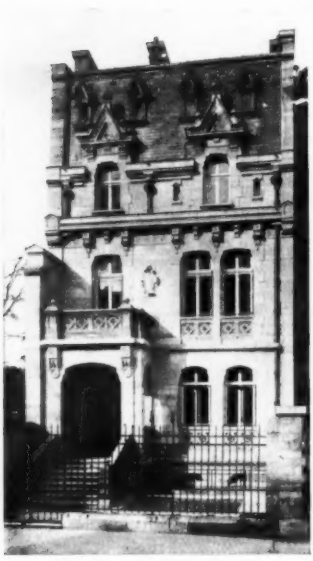
For Paris streets are monotonous, with a deadly dullness that only London streets of the first part of the century can equal. It is a different sort of dullness; while the older London architecture is dull through lack of form and art and variety, the newer Paris architecture is dull through an affected and attempted variety. They no longer build structures as featureless as those that line in the Rue de Rivoli, or edifices as sober and thoughtful as those that form the Place Vendôme or the Place des Vosges. They do much worse than either style illustrated in these different groups. No house, no structure of any kind, is now erected in Paris that is not plentifully supplied with pilasters, apparently deemed as essential as the windows or the enclosing walls. Every floor must have its balcony carried on stone carved corbels, and railed off with light iron grilles. There must, after a certain height, be a cornice, likewise carried on corbels. And over all there may be one or two stories, an attic, and a curved roof, or something pieced on to eke out the height. And when we have put casement windows to the openings, and lace sash curtains to these, we have obtained a design in the most approved Parisian style for block buildings. It is simple enough, and, in capable hands, possible of satisfactory and pleasing treatment, but when repeated a thousand times in a single street, and on every cross street and in every part of the huge expanse of Paris, and in every modern street of every modern town in France, it becomes monotonous and sickening. Its possibilities have long

since been exhausted: the surfeited student can scarce keep back a cry for something different.

Academic training in architecture may not be directed toward such an end, but this distressing monotony is one of the results it produces. As a natural consequence there is not in all Paris a single restful stretch of wall. What is left of a front, after the windows have been cut in it, is used as standing room for pilasters; or cornices and balconies straggle across it until, of plain restful surface, there is nothing at all. This would be bad enough, were the ornament applied to the walls good and sufficient; but, when most of it is very bad, hard, cold, unsatisfactory detail, verging to one or the other extreme, either too coarse and florid, or too refined and small, it becomes absolutely intolerable. But the real state of things is much worse than this implies; with all his respect for the past, with his dependence on precedence, with his ceaseless copying, his endless reproduction of past forms, a French architect is never so happy as when he is inventing a moulding or a column of his own, unless, indeed, it is when he is going further than this and is making a purely original Order. That most of these newly-manufactured additions to architectural knowledge are wanting in the very elements that make the Greek and Roman Orders good and great he does not seem aware; for, whenever the chance occurs, he gets busily to work, turning out aberrations and doing his level best to make his work as extraordinary and as individual as he can, doubtless under the impression that he is thereby showing a vast amount of originality and perhaps some little industry and invention.

THE MODERN RESIDENCE AS IT IS MADE IN PARIS.

Recent French architecture is very largely deficient in feeling, and this arises, in good part, from the



A PRIVATE RESIDENCE IN PARIS.

hardness and inefficiency of the detail. French architects appear quite incapable, even in their most academic designs, of throwing off their academic training. Their designs want life; they are deficient in vitality and feeling. Is it due to a striving after realities which the designer himself is incapable of producing? Is it due to a lack of appreciation of these qualities in architecture? Or is it due to a simple inability to do otherwise? Possibly all things may have their influence in one way or another; but, whatever the reason, the results are clearly in evidence.

The conditions under which architecture is practised in France apparently have their influence on this use of detail. French buildings divide themselves into three general classes. In one are the utilitarian structures treated in a utilitarian manner, admirable in its severity, though not additive to the beauty of the cities. In another class are ordinary blocks of city buildings, designed almost on a single model, calling for little effort at originality or variety on the part of the designer. In the third class are the more ornamental and monumental structures with which the soul of the French architect is delighted, with which the architects of other lands are dazzled, and by which, it is to be presumed, the architecture of to-day in France is to be measured. But, while few really monumental structures are produced, the possibility of their production is present to every one. It is small wonder, therefore, that the methods to be employed in more pretentious buildings should be employed in less important ones. The richness and overloading of many French designs; the constant employment of pilasters, especially where they are not needed; the introduction of new Orders and the invention of new detail,—all these may be but a survival of the idea that every man may design a masterpiece in his day, and his application of these things to every sort of building may only be an effort to keep his hand in.

SEWERS AND SEWAGE DISPOSAL.

By Rudolph Hering.

NONE of the public works of a city have a greater influence upon the health, comfort, and safety of the inhabitants than those which supply copious quantities of pure water for domestic and public purposes, and those which remove it after use, soiled and polluted by offensive waste matter, some of which may harbor and disseminate causes of ill-health and perchance of death.

It is therefore plainly one of the first duties of city officials to have such works built and operated in the best possible manner. The result of this care does not make itself felt at once as a flow of dollars into the city treasury: it appears, nevertheless, as a priceless benefit in prolonging or saving life and increasing its comforts. Benefits are so often reckoned merely in terms of money value that sanitary advantages are not at once recognized. No wonder, therefore, that in many cases improvements in water-supply and sewerage are delayed, with fatal consequences. Sanitary science in its progress is revealing the causes of infectious disease and the means of preventing it; pointing out every day with greater precision how the enemies to our health are brought into the midst of us, are nourished and propagated by our surroundings, and are allowed to slaughter the innocent citizens who know not how to provide efficient defences. And, commensurate with this progress, greater attention is given primarily to the selection of a good water-supply and almost equally to the proper removal and disposal of sewage. The relation of cause to effect is becoming as certain in sanitary as in mechanical science. The responsibility of city officials is being more clearly outlined, and neglect to give due consideration to this branch of knowledge must draw upon them the same condemnation as neglect of law in any other branch.

It was the original plan of both my editor and myself to treat the two branches of the problem in a single paper, entitled, "Problems of Water-Supply and Sewerage." But, when I came to write the article, we found that it was practically impossible to do the subjects justice in such narrow limits. We have decided, therefore, to devote one paper to each branch of the subject: and as in the last number of the magazine Col. Waring has treated the problem of municipal cleansing, it seems appropriate to first deal with sewerage, and then in a later paper treat the question of water-supply.

Nearly all the water furnished to a building becomes polluted therein by its use, and is then called *sewage*. Its collection, removal,

and disposal by pipes and other channels, together with all necessary appurtenances and other works, is defined by the comprehensive term *sewerage*. The collection and removal of rain-water or sub-soil water by the necessary works is termed *drainage*. In the subsequent pages we shall confine ourselves to the subject of sewerage, and follow the foul water from its origin within the buildings to its final disposal, considering particularly the more important requirements and a few of the difficulties sometimes met in fulfilling them, when making designs for new works or for extensions of existing works.

The subject of municipal control of house sewerage has received much attention during the last decade, with the resulting opinion that the design and execution of plumbing work should not be left to the house-owners themselves, because ignorance or wilful neglect on their part may cause injury or death to innocent persons.

Ordinances for the regulation of plumbing with reference to sewerage are of great importance to the community, the dangers from neglect to have proper appliances and arrangements for the removal of sewage being even greater than any arising from a neglect regarding appliances for the supply of water. The interaction of sewage and air circulating in the pipes, the traps and their operation, and the effects of heat and cold, make it important furthermore that the best knowledge and experience should be employed to aid the city officials in their task of enacting proper laws.

The sewage is collected in a main pipe which conveys it from the premises into the public sewer. Upon this pipe there is usually a main trap, intended to effectually prevent the air of the public sewer from entering the private sewer. Sometimes, however, it is omitted, and an air circulation established from the public through the private sewer to above the roofs of the buildings, the advantage claimed being a much better ventilation for the entire system, and therefore a better cleansing of the foul pipes.

We now trace the sewage through the public sewers along the streets of the city, down to the outfall. The designing of the system of pipes and larger channels is beset with greater difficulties than in the case of water pipes. The latter, running full and under pressure, need not be carefully graded, but this is necessary in the case of sewers, which generally should not run full, and in which the quantity flowing varies continually. Water pipes carry a simple liquid, while sewage is composed of both liquids and solids of the most heterogeneous character, some of which are liable to deposit and clog up the sewer, while others are liable to decompose and cause gases to form, plant-life to line the interior, and dangerous bacteria to find a nidus for propagation.

It is therefore necessary to pay special attention to all means that will reduce injurious effects to a minimum. The sewage must be given a regular velocity, which, if possible, should increase rather than diminish as the current advances. The least allowable velocity varies somewhat with the character of the sewage. It should always be sufficient to prevent a continuous deposition of the matter ordinarily entering the sewer. Where much sand and earthy matter, or certain heavy manufacturing wastes, are to be carried off, the velocity in, and therefore the slope of, the sewer must be greater than where only ordinary domestic sewage is to be removed.

Foulness is largely caused by a rough interior surface which retains matter. Formerly it was thought proper to build sewers with roughly-hewn stone walls, and sometimes even upon a bed consisting of the natural earth. Now the stones must be well dressed, the brickwork must be of the best, and all mortar joints must be carefully made smooth. The alignment of sewers should be made so that, if they are too small to be entered, it will be possible to sight through them from one point of access to another. At one point a lamp is held with a reflector; at the other the observer stands with a mirror, by which the light passing through the entire length of the straight pipe is reflected into his eyes and reveals deposits or obstructions. In small sewers all changes of direction are made by short turns inside of the manholes from which the inspection is made.

It has also been found that much of the foulness arises from improper junctions of sewers, or whenever the cross-section of the flowing sewage abruptly changes. Therefore attention is now given to proportioning them properly, giving them suitable curves and shapes, so that all eddies and irregularities in the flow which might cause retardations and deposits may be prevented.

The proper size for the sewers is of course a very important element in the design, as not only the efficiency, but also the cost, of the system is materially affected thereby. If too small, the sewers fail to perform their duty, and, if too large, their cost is excessive. The smallest size is not governed by the quantity of sewage to be admitted, but by the size of solid substances that find their way into the pipes. Practical experience, not theory, must guide us therein. It has been found advisable, both in Europe and America, after perhaps half a century's experience, that a public sewer, except on steep slopes, should not be smaller than 8 or 9 in. in diameter, on account of the frequency of stoppages when the sizes are smaller.

Where sewage alone is to be admitted, the pipes should be of sufficient capacity to carry the sewage entering them during the forenoon, when, as a rule, the greatest flow is observed. The quantity

usually assumed is the same as that of the water-supply furnished the inhabitants, adding, in some cases, a percentage for the ground water which is liable to seep into the sewers.

When rain-water is admitted, it is necessary to determine various elements in order to enable the engineer to proportion every part of the system most economically,—such as the intensity of the rainfall, the imperviousness of the surface, and its superficial character and slope.

The ventilation of sewers must be given due attention, so that currents of air will reduce their foulness and that the ever-changing quantities of sewage will not subject the superincumbent air to pressures that are necessarily communicated to all the house-traps, thus possibly destroying them as such. The most common method is by means of shafts, or so-called manholes, extending up to the surface of the street and having perforated covers. But, in climates where these are likely to be obstructed with snow and ice, other means are generally required, among which that of ventilation through house sewers, previously mentioned, is sometimes favored.

Even where the sewers are supposed to be self-cleaning, it is necessary to have means for creating a stronger current than the ordinary one, so as to flush out the deposits that invariably occur. For this purpose we have at the head of the small sewers flush tanks operated automatically, or by hand when necessary, so that several hundred gallons of water may be released within a few moments. Along the line of the sewer we have man-holes arranged so that they can be used as flush-tanks, or we have swinging gates, by which the flow may be temporarily stopped and stored and suddenly released, thus cleaning long stretches.

One of the essential general questions which city officials are called upon to decide is the character of the system in respect to the admission or exclusion of rain-water. In early times the principal reason for building sewers was to remove the rain-water from the streets and yards, and even now this is frequently the case; yet, owing to the general advancement of sanitary science, the necessity for the prompt removal of foul water is becoming equally apparent. In England, the mother country of public sanitation, we find the earliest examples of modern sewerage represented in its different systems,—the "combined" system, where both sewage and rain-water require underground removal, and the "separate" system, where the foul water alone requires it, and where rain-water can be left to flow away in natural channels or in less expensive artificial ones.

From a sanitary standpoint no difference between these two systems has been found. Theorists have endeavored to manufacture

opinion in favor of the "separate" system in this respect, but statistics have not sustained them. The cleanest and least odorous sewers at the present day, so far as my own observation goes, are found in the "combined" system as built in some of the European cities.

Time has demonstrated, in England and elsewhere, that choice between the two systems must be based on the questions of convenience and cost.

The "separate" system is not necessarily cheaper or simpler. When all rain-water must also be removed underground, the expense is usually greater, and the double system then required is more complicated than the "combined" system. The reason why the latter is used more in Europe than here is that it is desired to promptly remove the rain-water from the streets.

In America the application of the "separate" system is more extended for two reasons: one is that our rainfall is more intense than in Europe, and therefore a "combined" system is rather expensive for a small community; the other is that in many small towns sewage removal is more imperative than underground rain-water removal.

The difference between the two systems is not a radical one, as the proportion of rain-water admitted to the sewers varies. We have cases where about one-half of the entire quantity, and others where only roof and yard water, or where roof water alone, wholly or partly, is allowed to enter for flushing purposes. Finally, we have a complete exclusion of all rain-water, where, either on account of pumping or purification works, the admission of any would materially increase the expense. The most extensive instance of this kind is found in the North Metropolitan sewerage system of Boston and vicinity.

Memphis, Tenn., was the first large city in which complete exclusion was adopted, in a system built and patented by Col. George E. Waring, Jr. In extending the system to the suburb Chelsea, the local authorities adopted the regular separate system, based upon principles laid down by English engineers.*

The Shone system, as built in the World's Fair grounds at Chicago, likewise excluded all rain-water. The peculiar feature of this system, however, is the lifting of the sewage by compressed air at frequent points by so-called ejectors, whereby, under certain conditions, special advantages are obtained.

New Orleans is now constructing the regular separate system according to a design made jointly by Mr. George G. Earl, as chief engineer of the work, and the writer, as consulting engineer, in which a small amount of rain-water may be admitted when desired for flushing.

* Biennial Report of the Taxing District (Memphis), Shelby County, Tennessee, January 1, 1889.

The selection of the particular system and the proportion of rain-water to be admitted depend therefore on local and economical, but not on sanitary, requirements, and the selection should be carefully made by a competent engineer. Not only do different localities require different treatment, but in the same city or town we may have several systems working together. The upper blocks of a sewerage area necessarily exclude the street water. In a valley we may have the "combined" system and on a ridge the "separate" system. Again, an intercepting sewer may carry away the ordinary flow of sewage to a suitable place for treatment, while the storm water and diluted sewage may run into a stream.

It is therefore evident that care should be taken to adopt the best designs and contrivances for each particular case, irrespective of opinions advanced by the promoters of patents. Further, general plans for a complete system should be made early in the life of the city, so as to prevent inconsistencies and unnecessary expense later. The execution of the work and its adaptation to special requirements should keep pace with the growth of the city.

In conclusion, a few words may be said regarding the final disposal of sewage. When it can be accomplished safely by a direct discharge into a large river or the sea, this will generally be the most satisfactory mode, as, for instance, in New York, Boston, Philadelphia, New Orleans, and many other cities. When the sewage must be purified before it is discharged, we must then decide what method should be employed.

The purification can be made partial or complete, according to the requirements of the case. Complete purification can be obtained by intermittent filtration through sand of proper grain and depth. We have a number of cases where this method has been successfully employed for some time in England, France, and Germany, and we have lately commenced to use it in America. Through the excellent work undertaken by the Massachusetts State Board of Health, we have been placed in a position to design such works more intelligently and to better effect. They have ascertained the fundamental elements affecting the questions to be considered, and have given us data showing, for instance, that sand is better than soil; that the size of the grains and the quantity of sewage periodically applied stand in a definite relation to the degree of purification. We know better than before what effect a constant use of the same filter has upon its usefulness, and what means are necessary to make it permanently effective in winter and summer and from year to year. From the best filtering areas, both in Europe and America, we obtain thoroughly purified sewage,—purer than some waters furnished for domestic consumption.

There are many instances where clean sand, the most suitable material for purification, cannot be had in sufficient quantities, and then we must be content to partially purify, or merely clarify, the sewage. This is done by mixing with it certain chemicals, notably lime, salts of iron, or alumina, by which the suspended and some of the dissolved organic matters are precipitated, leaving a clear liquid to run off. But these methods still leave about one-half of the organic matter therein. Many such cases of chemical purification are found in Europe, and in our country we can name Worcester, Mass., and the World's Fair at Chicago as the best instances.

What system of disposal to select, particularly when a sufficient quantity of the proper sand cannot be had, is often a difficult question. The expense of precipitation is often a serious objection to its use, and the cost of a long outfall sewer to some large water course, where a discharge is permitted without purification works, may also be great. But, whatever may be the expense, a proper solution should be found, and it may be well to consider that the time is certainly approaching here, and has already arrived in some European countries, when sewage must be purified before it is discharged into a stream. Therefore no plans for a sewerage system should be adopted without due consideration of a *future*, as well as a *present*, proper disposal of the sewage.

PAVEMENTS, SIDEWALKS, ROADS, AND BRIDGES.

By Major J. W. Howard.

CITIES, States, and nations are organisms which grow and improve in proportion as they care for their moral, mental, and material welfare. Their success depends upon the engineers directing their constructions as much as upon their teachers, law-makers, and merchants.

Engineering, in a broad sense, covers all constructions where materials are combined in various forms for various purposes. This profession has existed for more than 6,000 years, as is shown by the Pyramids, obelisks, and ancient canals of Egypt. The walls and terraced hanging-gardens of Babylon, built later, show the growth of engineering science. The aqueducts of Rome, with their tiers of arches, are also its monuments.

Roads and bridges appeared simultaneously with other great engineering undertakings. No one can read about the Via Appia and other highways of the Roman empire reaching over Europe, carrying military and commercial power, law and order, throughout the then known world, without respecting the engineers who laid these lasting foundations of modern civilization. Of such importance did Cæsar deem the construction of a bridge over the Rhine in 55 B. C. that he described it so minutely that a modern engineer could easily reproduce it. Where traffic became concentrated near and within a city, the Romans recognized the necessity of using stable materials for the surfaces of their streets. They early discovered that increased first cost diminishes cost of subsequent maintenance,—a fact which is the keynote of economic paving.

We realize the great problems engineers have had to solve in providing for the safety, prosperity, and health of the public, so enormously increased in numbers since the time of Columbus. Europe's population has grown from 50,000,000 to 380,000,000, and that of the Americas from a handful of colonists to 126,000,000 people. No works have been more important or vitally necessary than the streets and highways facilitating intercommunication, so necessary to the very existence of civilization. This importance may be realized by reading Bergier's "Histoire des Chemins Romains" (History of the Roads of Rome), or by consulting a few of the many works on this subject published at intervals by able engineers since 1547.

The French early recognized the construction of bridges, roads, and streets as a special science, and established more than a century ago their renowned École des Ponts et Chaussées, whose graduates have sole charge of the roadways and bridges of France and the pavements of her cities. The results astound a visitor the moment he enters that country.

The progress of American roadways and street-pavements has been slow, with a few well-known exceptions. The history of these constructions in America can be divided into three periods: first, ignorance and apathy,—a state of affairs found in many communities, especially where the people have never seen well-built streets and roads; second, empiricism or rule-of-thumb, influenced by conservatism and habit, which keep bad pavements, sidewalks, roads, and bridges in many communities for years; third, good engineering construction. Many States, counties, towns, and cities have awakened to the economy and benefit of properly-constructed streets, roads, and bridges, and are acting accordingly. But there are still many cities which, because of unattractive, rough, noisy, dirty, and poorly-paved streets, repel successful and wealthy retired people, to the social and financial detriment of the place. Washington obtains many of its best permanent citizens because of its handsome, well-paved streets.

The paving of streets and the building of roads and bridges are too often entrusted to the care of men who lack long, careful, and special training, and who have been either unwilling or unable to investigate, inspect, tabulate, and profit by the experience of their predecessors and of men elsewhere. City after city, after much difficulty, a long struggle, strong opposition (usually political), and costly experiments, has taken pavements, water-works, sewers, etc., out of ignorant, apathetic, or political hands, and placed them in charge of men who apply scientific methods, and who profit by the recorded experience of other cities. The results do credit to the cities, their mayors, and administrative officers, as well as to the engineers.

The experience of a city in paving should be recorded and tabulated from year to year, and thus become cumulative. The short terms of office too often allotted to city engineers make tabulated experience the more necessary. A public official who makes public experience a private matter does wrong; he will be a failure. If he neglects to properly analyze and record in official books the cost of work under his charge, such as the first cost and maintenance per square yard of the different kinds of pavements, he cannot demonstrate what he has really accomplished, nor will he be appreciated and receive the final benefit.

The materials which each city or county must use in the construc-

tion of its streets and roads are often largely governed by local conditions; but how these shall be employed, and whether or not it is best to bring better materials from a distance, can only be decided by an engineer familiar with roadways and pavements. Each community should constantly or periodically employ a competent engineer for paving and road-construction. He would save to the city far more than his compensation, and produce better results.

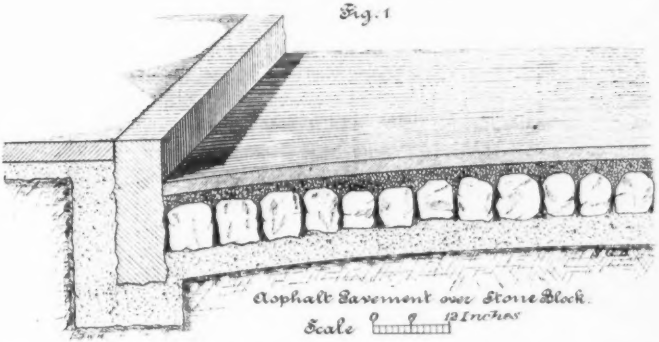
The question of cost of pavements and roads is a relative one. Prices of the same kind of pavement or class of roadway are not the same in all places. True economy considers not only first cost, but maintenance also. It takes cognizance of other expenses depending upon pavements, as cleaning, sprinkling, and indirect private expense of citizens arising from the cost of traction and transportation of persons and merchandise throughout the city. We must study the cost of repairs to vehicles and harness, the number of horses needed and the wear upon them, weight of loads, effects of dry, wet, hot, and cold weather, and of the dust from the street which affects our health and possessions.

In order to have a standard, it is well to define a theoretically perfect pavement.

A perfect street-pavement would provide a surface for the easy passage of vehicles. It would offer the least resistance to traction consistent with a foothold for horses. It would be easily cleaned; it would be impervious to moisture; it would retain no filth within it, and produce from itself no odor or dust; it would be as noiseless as possible, and otherwise of sanitary value. With it there would be no jarring, either of vehicles passing over it or of adjacent buildings. It would be as durable as is consistent with the necessity of continual, quick, and easy repairing of its surface. It would be made of material that can be cut through and firmly renewed over gas and other pipes. It would be so laid as to be easily and quickly drained. It would be such that it could be crossed on foot at any point.

All good pavements consist of a foundation, or support, and a wearing surface. If durable foundations are not used, the wearing surfaces soon become uneven from frost, heavy traffic, or settlements. The best foundations for the pavements of large cities are made from concrete. They should be six inches thick for heavy traffic, and at least four for the lightest traffic. Concrete is usually made by uniting one part of an American hydraulic cement, two of sand, and four or five of stone, thoroughly mixed when wet. The stone should be crushed to less than $2\frac{1}{2}$ inches in size. A good concrete can be made by experienced men from one part of cement and six to seven parts of gravel, free from loam. Another foundation is that of crushed

Fig. 1



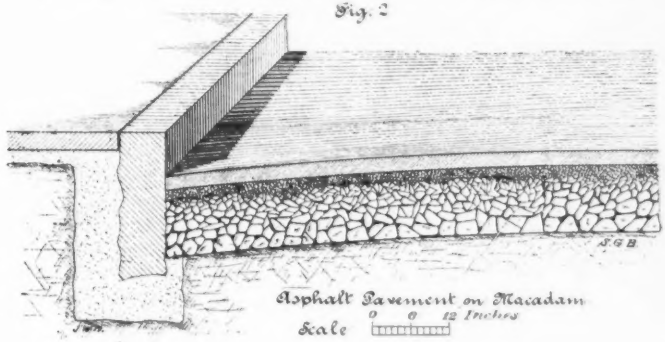
stone coated throughout with an asphaltic cement; it can be rapidly laid.

Old stone-block, brick, cobble-stone, telford, macadam, and gravel roadways are largely used for a foundation, especially for asphalt pavements (Figs. 1 and 2), by first covering the old pavement with a fine bituminous concrete, called binder, made from crushed stone 1 inch and less in size, heated and mixed with a bituminous or asphaltic cement. The binder is spread to a minimum depth of 1½ inches, bringing the old pavement to an even surface preparatory to laying the asphalt pavement upon it.

The wearing surface, be it asphalt, stone, brick, or other material, is placed upon the concrete or other foundation to receive the wear of traffic, and make possible repairs to the surface which will not disturb the foundation.

There is no everlasting paving material. No pavement should be

Fig. 2

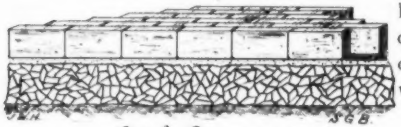


left upon a street until worn beyond repair. Modern practice compels contractors to maintain their pavements in good order from 5 to 20 years, which is possible where the foundation remains undisturbed and the wearing surface is kept in repair. This is the cheapest as well as the best way to provide a city with good pavements.

The materials used with more or less success for pavements are, alphabetically, as follows: asphalt of different kinds, qualitjes, and mixtures, laid without joints; asphalt blocks; asphalt imitations; basalt blocks; boulder stones; bricks of various kinds; coal-tar or gas-tar compounds; cobble-stones; dolerite blocks; granite blocks; hill stones; limestone blocks; quartzite blocks; sandstone blocks; syenite blocks; scoria or furnace-slag blocks; trap blocks; wooden blocks of various kinds and shapes.

I omit telford, macadam, and gravel roadways,—to be described later when we turn our attention to roads, for they are not city pavements. They belong to parks, suburbs, and country roads. If used under city traffic, macadam, telford, and gravel become ruinously expensive, because of continuous repairs. They are unhealthy within a city, because their dust spreads and carries disease-germs everywhere.

Fig. 3



Brick Pavement.

Scale 0 6 12 Inches

The following materials are to be avoided, as a rule, for the wearing surfaces of city pavements: cobble, boulder, or hill stones, which make noisy, uneven, unsightly, and unhealthy pavements; sandstone, with a few doubtful exceptions; trap, dolerite, or basalt blocks, because they cannot be made into even, regular blocks, pavements made from them being at first rough, and the blocks afterward becoming rounded and polished, like cobble-stones.

Artificial blocks, embracing wooden ones of various kinds and shapes; asphalt blocks made from crushed stone cemented together with asphalt; bricks of ordinary clay, fire clay, shale, or some combination of these, mixed, prepared, and burned according to various systems good and bad; and blocks moulded from furnace-slag,—are to be used only after due investigation as to their quality, uniformity, strength, and the conditions of traffic and climate to which they will be exposed.

Asphalt blocks and a few brands of paving-bricks (Fig. 3) of certain clays and shales (alone or mixed) have been used, especially upon concrete foundations and under light traffic, with success.

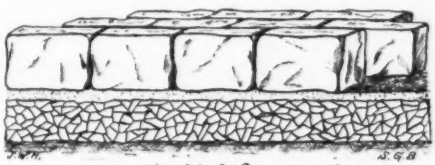
Paving-bricks vary so much in composition and quality in different localities that it is difficult to determine in advance whether the pavement will be good or bad. Caution is necessary in introducing paving-brick as an economic, permanent paving material in large cities. It is probable that a few brick manufacturers may succeed in standardizing the quality, form, and size of paving-bricks, and thus produce definite, reliable, and economic results. In brick paving the best is certainly the cheapest.

Coal-tar, under whatever name, alone or in mixtures, must not enter into the wearing surface of pavements. Under the name of vulcanite it has entered some cities to their cost.

Wooden-block pavements in this country serve as a temporary street-covering during the first decade or two of a city's existence, provided wood is cheap and obtainable in large quantities. Eventually heavy traffic and the administration of public health and finances compel the adoption of better materials.

The wooden pavements upon certain streets of London and Paris are laid upon concrete foundations. The blocks, of selected wood, cut to true parallelopipedons, are laid with great care. These pavements are constantly watched and repaired, the entire surface being gradually renewed, under heavy traffic, within four years, and, under lighter traffic, within six years. The cost, including maintenance, amounts to the enormous sum of from $6 to $12.72 per square yard,—a price no American city would pay for this form of doubtful luxury.

Fig. 4



Granite Block Pavement
Scale 0 6 12 Inches

The materials mostly used in successful wearing surfaces are certain granite, granitoid, syenite, and quartzite blocks (Fig. 4). Experience is the best guide to the quarries furnishing the best blocks. Transportation is so expensive that certain quarries are not available for serving some cities. A few kinds of asphalt pavements have proven of much value. Washington, Buffalo, Philadelphia, New York, and some eighty other cities in this country, as well as the great capitals of Europe, demonstrate the advantage of good asphalt pavements.

Asphalt pavements are laid in a continuous sheet upon a prepared foundation, either concrete (Fig. 5) or a previous pavement of old stone block or other material. These asphalt pavement surfaces are

composed either of a natural asphaltum compounded with sand and a little limestone dust, or of a natural asphaltic limestone pulverized and then compressed upon the street. Asphaltic sandstone has not yet succeeded as a street-pavement. Experiments are in progress which may make it possible to use with good results this asphaltic material compounded with a little refined asphalt and asphaltic limestone.

The three asphalt paving materials which at present are the most successful are the long-established Trinidad asphalt and the newly-introduced asphalt from Venezuela and California. The European material is, with a few exceptions, asphaltic limestone.

Specifications describing in detail how different kinds of pavements should be laid can be had free, upon application to the department of works or city engineer of any large city. It is a good plan for a city to distribute freely to its newspapers and prominent citizens copies of the specifications for pavements. There is no greater check upon dishonest or incompetent work, no greater assistance to an honest administration.

City sidewalks and suburban footpaths are not generally constructed with that uniformity of alignment and good material which characterize them in a few communities. Near cities, towns, and villages it is wise to construct a raised footpath on one side of the road, separated from it by rough curbstones or large stones embedded in a row, a paved gutter, or a simple macadamized depression.

City sidewalks cannot receive too much attention. The first requirement is a good curb or border-stone (Figs. 6, 7, 8, and 9), set upon a concrete or brick or sand support so firmly that neither vehicles or frost can displace it. It is a mistake to have the curb rise more than 4 to 6 inches above the gutter. A shallow gutter compels good street-cleaning. It facilitates crossing the street on foot at any point. Deep gutters are not necessary for storm-drainage. A city which can

Fig. 5

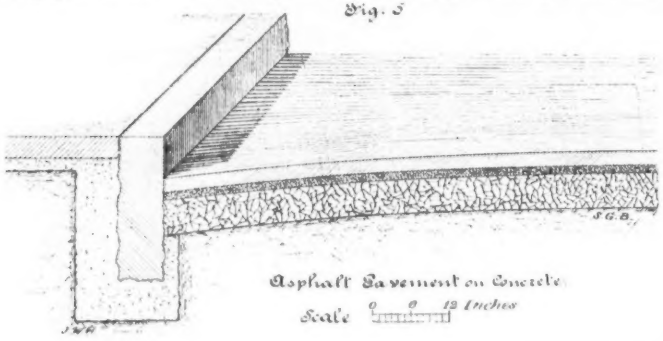


Fig. 6

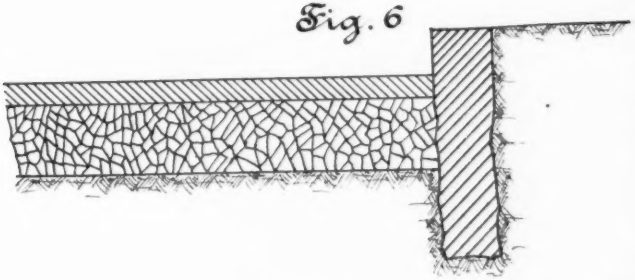


Fig. 7

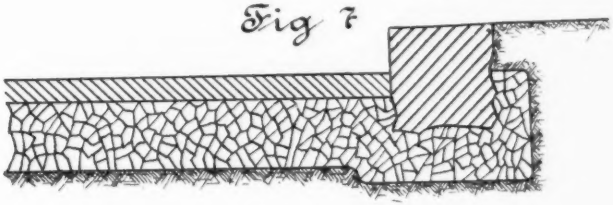


Fig. 8

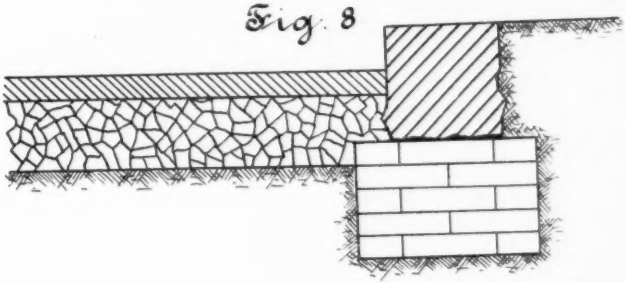
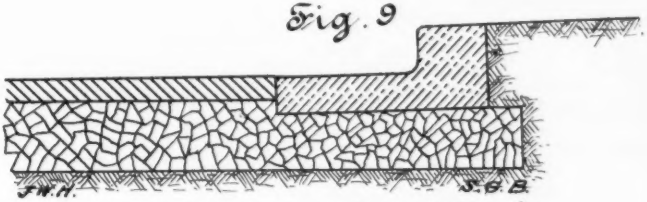


Fig. 9



F.W.H. S.G.S.

Various Street Curbs

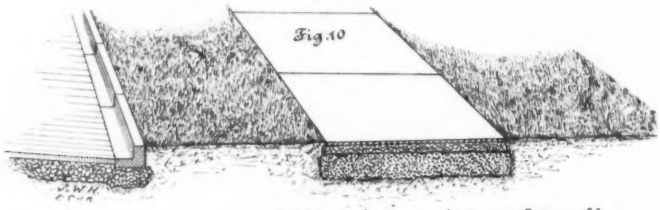
Scale 0 6 12 Inches

pave can have storm-sewers. The vertical face of the curb should form an angle with the street-pavement. The pavement of the street should not be rounded up toward the curb with stone or other material, as on some streets in Chicago, Omaha, and elsewhere. This makes an unsightly, inconvenient gutter,—one that cannot be kept clean.

The best sidewalk materials are carefully cut, large, flat pieces of stone, well embedded upon sand, deep cinder (treated with cement), or concrete foundation. The stone can be either granite, certain bluestones, or a very few kinds of sandstone. Limestone must be avoided. Portland cement, combined with crushed granite or other sharp, fine grit, is used with perfect success for city sidewalks. A solid foundation is absolutely necessary to the success of these artificial (cement) stone sidewalks (Fig. 10). The proper proportion of the surface is one part of the best cement and one or, at most, two parts of grit.

The enactment of a sidewalk law, or even a more strict application of existing laws on the part of our city administrations, would bring about an agreeable surprise, because better results are obtained when a city insists upon uniform and durable sidewalks, laid according to plans and specifications approved by the city engineer or other proper authority.

Suburban and country roads, as well as pleasure-drives, are best con-



Artificial (Cement) Stone Sidewalk

structed as a rule from telford, macadam, or gravel, or some combination of these. I will content myself with brief definitions of telford and macadam, leaving details to be sought in special existing treatises.

A telford roadway (Fig. 11) is constructed as follows: The roadbed, being properly graded and excavated, and the proper provisions for drainage being in place, is first covered with large spalls, or kidney-shaped stones, from 6 to 8 inches deep, placed close together on end. The interstices are wedged full of smaller stones. The upper portion of the roadway is then constructed of a layer of crushed stone 3 to 4 inches deep, with another layer of finer crushed stone for a wearing surface. The whole mass is compacted by repeated rolling during construction.

A macadam roadway (Fig. 12) is constructed in the same way, ex-

Fig. 11

Telford Road

cept that the large spalls or foundation stones are omitted and the thickness of the underlying crushed stone is increased.

Desirable and eventually economical as macadam roads in country districts prove themselves to be, nevertheless, for some time to come in vast sections of our country, dependence must be placed upon earth roads. Our earth roads can never be made satisfactory, especially in the fall, winter, and early spring, but they could be so improved that they would sustain traffic at all seasons and keep communication open until in due time they should be replaced by gravel and macadam surfaces. The great weakness of earth roads is the lack of proper drainage. Sometimes a slight change in location is an advantage. When properly located and properly sub- and side-drained, they are fairly good in the worst seasons.

The science of bridge-building requires a knowledge of higher mathematics, strength of materials, and recorded experience. The construction of railway bridges can be undertaken only by men of special education and training. Roadway bridges (with which this article deals), whether of metal, stone, or wood, and their combinations, are cheapest and safest in the hands of engineers. They alone can obtain a maximum strength at a minimum cost.

Whereas very few railway bridges fail, because administered by scientific men, many highway bridges (an average of seven per day) fall, fail, or become dangerous in the United States. This means a loss of life, property, and business to people who can the least afford it. A tour in a carriage through parts of Massachusetts, Connecticut, and a few other States will demonstrate the economy and safety of employing competent engineers in connection with even the smallest bridge. The fees paid are not a tenth of the saving effected.

It is well to remember thefollowing facts in connection with the superstructure, orbridge proper. Steel is cheaperthan wrought-iron. Cast-iron, in all forms, should be avoided. A through-bridge, if of metal, is cheaper and leaves more waterway under it than a deck-bridge.

Fig. 12

Macadam Road

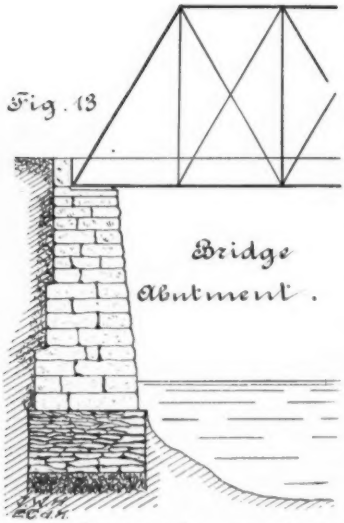


Fig. 13

All parts should be accessible for painting. Metal bridges must be kept painted, lighter colors revealing rust. Steel bridges are in the end more economical than wood, except in a few places in our country. Stone bridges, well constructed, are the most durable, and need very little attention. They are eventually the most economical.

Bridge abutments (Fig. 13) are governed in general, as to their construction, by the following rules, which at the same time demonstrate the necessity of placing competent men in charge. The soil under the foundation must be stable rock, gravel, or clay. The foundation must be deep enough to prevent scouring. The distance between abutments must be a little greater than the width of the stream at the point bridged. Foundations are best started with a layer of large, flat stones; where necessary, two layers of 4-inch planks at right angles can be used. It is wise to next introduce a strong cement concrete. The cement used throughout must be truly hydraulic, which will permanently set under water,—true of very few domestic brands. A rough rule requires the thickness at the base to be two-fifths of the height of the abutment. The slant or batter of the masonry is safe at ½ inch per foot of height. The masonry must be well bonded with headers and stretchers. The stone used is best laid on its natural bed, and of a kind which experience proves durable. Exposed joints should be less than ½ inch and firmly pointed with cement. The bridge seat on top of the abutment should extend well over the center of the wall. Wing walls must not be forgotten. Back filling of loose stone and mortar must be carefully attended to. True economy dictates the use of one part of cement and one of sand in the mortar used. The masonry should be kept free from water during erection.

Whenever a city, county, or State desires to construct a bridge, plans, specifications, and prices can best be obtained by advertising, especially in a few engineering papers. Then the employment of a competent engineer, temporarily or otherwise, will secure lasting and economic results.

ELECTRIC WIRING AND THE FIRE HAZARD.

By F. E. Cabot.

PERHAPS no element among those which enter into the causes of fire and fire-losses has caused more discussion and difference of opinion than electricity, since its introduction for light and power during the past decade. When the dynamo and its use to produce electric current first came before the commercial world, there was some distrust of this strange force, which the crude methods first employed did little to overcome. The march of progress was rapid, however, and within a short time the introduction of the incandescent lamp—"light without heat," as it was so often called—gave rise to a hope, never yet realized, that a method of illumination which could be used under all conditions and in all places had at last been discovered. Insurance officials throughout the country were delighted at the thought that the hazards of friction matches, of inflammable oils, of the contact of light-giving flame with inflammable gases and dusts in the air, were to be overcome by the use of the new light, and that no new hazard would follow in its train. In some parts of the country, insurance companies went so far as to put a premium on its introduction, by reducing rates of insurance on certain classes of factories when lit exclusively by incandescent light. But as the introduction of electricity became common and its use was extended to all parts of the country and to all sorts of buildings, rumors began to arise of fires from some cause or causes hitherto unknown, where electric wires were run, until within the last two years the pendulum has swung in the opposite direction, and not only insurance officials, but the public, are inclined to refer to electricity as the prime factor in the great increase in the fire-waste throughout the country. No sufficient proof has ever been given, or even offered, that this is the case, nor does the writer believe that up to the present time the use of electricity has been the only, or even the greatest, factor in the increase of loss by fire from which this country has suffered during the past ten years. Furthermore, there is little doubt that, with reasonable care of installation and properly-designed apparatus, electricity can be made not only a convenient but a safe method of producing light and power wherever needed, and can be used in many places where other forms of light and power are unsafe and undesirable. Yet any one who will read the quarterly reports issued by Mr. W. H. Merrill, Jr., electrician for the Chicago Fire Underwriters' Association and the Underwriters' Electrical Bureau of Chicago, will see that under

present conditions the use of electricity for light and power adds considerably to the danger of fire. Mr. Merrill says: "Nothing approaching a complete statement of the country's fire-loss from electricity has been secured, because we have less than thirty-five electrical inspection departments in the country, and because so many fires destroy all evidences of their origin. . . . No complete statistics can be gathered from this report, and *no quotation should be given from it without the foregoing explanation.*" This summary shows that 475 fires, with a loss amounting to $1,415,610.25, were reported to him as having occurred in this country alone during the year ending October 1, 1894. This is approximately 1 per cent. of the fire-loss for the year,—a sum of sufficient importance to call attention to its causes and the means which may properly be taken to reduce it.

The writer believes that any one who cares to study the causes of fires started by electricity will be convinced that a very large proportion of these fires are from defects which would never have existed had the work of installation been done by men having a proper knowledge of the subject. He has no intention, in making this statement, of saying that the fault lies wholly or largely with the men themselves. The enormous strides which the development of this force has taken within the past ten years have made it necessary to employ, for most of the work, men whose whole knowledge of the subject has been and is most superficial. All the knowledge which workmen, or, in fact, any considerable number of persons, had on the subject was derived solely from familiarity with battery currents, and very naturally the means which had been found entirely sufficient to control these currents were still believed to be adequate. Of course, it took but a short time to show that such means would no longer suffice, and efforts were at once made to secure greater protection; There can be no reasonable doubt that, had the development of the purposes to which electricity could be applied, and of the means for producing and supplying the current adequately and economically, been, even for a time, checked in its advance, sufficient means of control would have been developed. But for each step in the advance of protection, the art advanced two; higher pressures were produced, machines capable of developing larger quantities of current were built, and the number of uses to which the current could be put were multiplied. Even within the past year there has been a decided tendency to increase the size of dynamos and the pressure at which they are intended to be operated, although no corresponding advance has been made either in insulation or in method of control.

In another way, too, the advance of electricity has increased the danger of fire. Through the use of the so-called low-potential system

of lighting, the dynamo current now goes into every mercantile building and into almost every house in the larger cities throughout the country. Under ordinary conditions the current used for this kind of lighting makes itself known only through the light of the incandescent filament, for, though a certain amount of heat is developed in the lamp, it is not sufficient to attract attention. As a result, people felt that this current and the "light without heat" were perfectly harmless, and that the wires and lamps could be put anywhere with safety, so that the poorest forms of insulation were considered sufficient and the fusible cut-out was thought to be a perfect form of protection. In the same way the lack of knowledge and consideration of the danger from this source led to carelessness in construction-work, and allowed the employment of incompetent workmen without proper supervision. There can be no doubt that a very large proportion of the fires from electrical currents would never have occurred, if all the work had been first-rate. Any one who has had to do with work of this sort knows that there are to-day many electric-light plants, with none of the better forms of protection or insulation, which have run for years without a suspicion of danger from fire. In these cases careful workmanship supplied the want of better materials.

In order to understand clearly why there have been so many fires, it may be necessary to separate the ways in which they occurred, and to consider certain of these by themselves. Of the 475 fires referred to in Mr. Merrill's summary, 59 were from contact between conductors carrying electricity for light and power, and wires intended to carry only "battery" currents. These wires are, as a rule, only of sufficient size and insulation for their normal use, and, though much has been said upon the subject, are to a very considerable extent without devices providing for automatic opening of the circuit whenever a current of great pressure or quantity passes over it. Now, there can be no doubt that every one of these fifty-nine fires could have been prevented by the use of proper fuses on the battery lines where they enter buildings, and by a little more care in the construction and maintenance of such lines. The telephone companies in many parts of the country are showing how this work should be done, as they now realize how important it is that all danger of fire from this cause should be reduced to a minimum for their own protection; and in some large cities, where public sentiment against overhead wires has made itself felt, other companies having overhead "battery" lines are taking the necessary steps to protect their lines; but, in a great majority of cities in the United States where electric-light and power lines exist, much still can and should be done to lessen this danger.

One hundred and ten fires were from "grounds,"—that is, from the

diversion of the current from its proper conductors to other substances making electrical connection more or less perfectly with the earth. It is fair to assume that reasonable care in the placing and maintenance of these conductors would have prevented one-half, at least, of the fires and losses from this cause. Again, nine fires resulted from the use of the *grounded* street-railway currents for commercial lighting and power, in spite of the objections urged against its use by insurance inspectors, which objections were the for most part based on the experience acquired early in the use of dynamo currents for lighting and power, and to which attention was called as early as 1882 by Mr. C. J. H. Woodbury, then in the employ of the Boston Manufacturers' Mutual Fire Insurance Company, who was, so far as the writer knows, the first person in this country to take up the hazards of electricity from the insurance point of view. He clearly pointed out at that time that one of the chief hazards then existing in the use of dynamo currents was that arising from the employment of the earth or grounded conductors for the return current. In his book, "Fire Protection of Mills," published in 1882, Mr. Woodbury says: "Each machine should be used with a complete wire circuit, and connection of wire with pipes, or the use of ground circuits in any other method, is absolutely prohibited." This rule has been published in every set of rules issued in the interests of insurance since that time. Yet the writer has been forced more than once to listen to an elaborate argument to prove that the method objected to, which, as Mr. Woodbury showed, was unsafe and therefore undesirable from the insurance point of view, was one which it was perfectly proper to use, even with the currents used on railways, which are of high voltage and much greater in quantity than anything known when the first insurance rules were issued. These nine fires can all be justly charged directly to the managers of the power-plants furnishing such current, who were willing to jeopardize life and property for the sake of the small amount of money to be derived from the sale of such current for use in mercantile or residence buildings; or, if they plead that they did not realize the danger to others, then this loss should be charged to those who supplied the machines and apparatus for generating this current. Such persons must have had ample opportunity, through insurance rules, if in no other way, to realize the danger which would surely follow, and were bound by the common laws of humanity to give this information to all purchasers of their apparatus.

There is another way in which these grounded circuits of large volume and high potential are liable to increase the fire-loss, and that is through what is often termed the "return" current passing through the earth. When the grounded trolley circuit was first used, it was

thought that the earth would furnish ample capacity for the return circuit, and that no wires would be needed for this purpose. It took but a short time, however, to prove the fallacy of this reasoning. Reports began to appear in the newspapers of shocks received from water-pipes and gas-pipes, and of motors run by attaching a wire to different pipes or grounded conductors within the same building. These reports were at first laughed at and believed to be erroneous, but in the course of time the attention of insurance officials, officers of telephone companies, and city officials in charge of water-works, was drawn to certain strange phenomena, and accurate tests were begun. These tests at once showed that the earth under normal conditions was far from being an adequate conductor for the current necessary to operate large street railways. The West End Street-Railway Company of Boston found a drop of potential between the power-house and parts of their longer lines of considerably over 50 volts. A road in Pennsylvania, whose power-house was located directly on a river, and whose line ran near the same stream, built their line without return wires, and trusted to ground plates in the river to furnish the balance of the circuit. Yet, when the dynamos were started and an attempt was made to operate the road, it was found impossible to obtain current enough to run one car.

As this investigation was carried on, new and striking facts were noted, and it was found that the current, for which the *earth* was to provide a circuit, was passing into all metallic pipes laid in the earth near the path of the current, and was using them in its return. Currents with a pressure of 8 to 10 volts and a quantity varying from 5 to 25 amperes were shown to be passing along gas- and water-pipes within the same building. A difference of potential of from 10 to 20 volts was found between the street-car rails and hydrants on water-pipes within 20 ft. of them. A spark was seen to jump between the ends of the rails laid on a swinging drawbridge, when the draw was turned, and on measurement a current of 500 amperes at a pressure of 15 to 17 volts passed over the wire put in to connect the ends of the rails. The writer has every reason to believe that within a short time current of this nature has passed between the gas- and water-pipes in a building in Boston in sufficient quantity to melt off the soldered connection of the gas meter. Such statements may seem unreasonable, but, except in the last case, they are capable of definite proof, and have been recognized as reliable by competent engineering experts.

Now, the effect of currents of great volume and potential, wandering as it were through the earth, is certain to make itself felt, as it is already showing the beginning of its work in the destruction of metallic pipes and conductors in the earth. This destruction, though slow, is absolutely sure wherever pipes, or uninsulated underground conductors,

form a part of the railway circuit: for electrolysis depends wholly on the amount of current passing out of a conductor and into another of a different conductivity. The reply will probably be made that proper bonding of rails and ample return wires in the ground will prevent any such results; but bonds often break, and connections underground are constantly weakened by corrosion and are liable to give way, and, when they are defective, the current must find another path. Moreover, there is nothing more fixed than the law that in a divided circuit the current divides in the inverse proportion of the resistances of the paths by which it goes, and, no matter how large an amount of return wire is provided, some part of the current will certainly go through the earth, and will have an injurious effect on the metallic pipes contained therein. Sooner or later this effect will show itself, in deterioration of such pipe, and, so long as the single-trolley grounded circuit is used, there is no way of escaping from it, unless an alternating current can be used. Let us hope that an efficient substitute for the present system will be found before these effects become serious.

Now, with reference to the possibilities of overcoming the dangers which arise from the use of electricity on metallic circuits, it is reasonable to believe that all which have thus far been encountered can be overcome. That this may be accomplished as speedily and as completely as possible there must be thorough coöperation on the part of all who encounter the problems brought forward by the increasing use of electricity. It seems desirable at this point to say a word as to the work which the insurance companies throughout the country are doing to solve these problems. The work which Mr. Woodbury did in this direction for the Associated Mill Mutual Insurance Companies, to which allusion was made above, roused the interest of insurance men throughout the country, and, as a result of his work, insurance organizations have endeavored to lay down rules by which the hazards introduced by the extended use of dynamo currents could be lessened, even if not entirely overcome. Their efforts have been met by the men who were engaged in the manufacture and sale of devices and apparatus for this work in very different ways. On the one hand, the insurance inspector has been received as a friend who was working for the best interests of all concerned: on the other hand, he has met opposition of the most bitter kind. No one realizes better than the writer that the first work of any man who undertakes the problem from the insurance standpoint has been, as a rule, crude. In fact, until recently, this has been almost of necessity the case, for each man has been obliged to work out each problem with little assistance and under circumstances unfavorable to mature consideration of the result. Practically no literature on the subject existed, and, until within a short time, there has

been no way in which the experience gained by one inspector was, or could be, made useful to others. As a natural result, the rules in force in different parts of the country differed in many points, and were, in part at least, the result of rather hasty judgment. Within the past two years, however, and as a result of the efforts of a few earnest inspectors, this difficulty has been overcome, and means are at hand by which the reports of their work and the experience thus gained are brought together, and uniformity of practice and rules is made possible.

The insurance companies have provided suitable means for testing apparatus, conductors and devices for electrical work, and have thus afforded an opportunity, to anyone who will ask for it, of knowing something, at least, of the safety of any new material or device before it is put upon the market. It remains to be seen how far their efforts will be seconded by those interested in the other side of the problem, and to what extent engineering experts, architects, and the public at large will coöperate. If their assistance can be gained: if manufacturers will avail themselves of this opportunity for test; if experts called upon to choose the best forms of apparatus will use the information thus made available,—a great work will have been accomplished. The insurance interests have taken up the problem for their own benefit, but are only too glad to allow the public to profit by the knowledge thus acquired. It is in this way alone that the best results can be obtained.

The other important factor, which can only be removed by education, by a better general understanding of this great subject, is the danger arising from the employment of unskilled and incompetent workmen. When the work of placing and arranging wires, switches, motors, lamps, and the many other details of an electric-light or -power system, is done in a thorough manner by men who have been properly taught, the number of fires caused by electricity will diminish. When architects and engineers realize that a circuit for this purpose cannot be safely put into any space which chance alone provides, and that as much energy can be conveyed through a copper wire the size of a pencil as through a large steel shaft, then good workmanship and proper devices will make safety possible, and the demand for good work will drive incompetent men from the field. Much has already been done in this direction, but much remains still undone. First cost alone is too much considered, and it is only through a better general knowledge of the subject that the desired end can be reached. Let the facts be known, even if some forms of apparatus have to go out of the market. The good of the public is, in the end, the good of those directly connected with the development of this great power, and no small or temporary delay will be a disadvantage, if through it the safety of life or property is gained.

MINE MANAGEMENT AND SUPERINTENDENCE.

By Covington Johnson.

IT is said that a capitalist once sent on a steamer from San Francisco to the Gulf of California an engineer and a stamp mill, saying to the former; "You have a mill; choose me a mine and draw for funds." This story is not credible, but such exaggerations are used occasionally to point out the follies of men. It is said that approximately 90 per cent. of merchants fail. When folly is linked to folly, as in the case of the above capitalist and engineer, the enterprise must perforce go under. The great mistakes in mining, and those most frequently made, are: first, the hurry to get up some class of reduction works before the mine is sufficiently developed; second, mistaking the class of reduction works needed; third, overcharging the mine. There has been many a ten-stamp, dividend-paying mine swamped under a forty-stamp mill. The capacity of a mill can always be enlarged, but the money expended in excess of capacity is forever lost. There is no more painful position for a superintendent to occupy than one where he is expected to keep a forty-stamp or even a twenty-stamp mill supplied from a ten-stamp mine. It is sometimes possible to do this for a few months or even a year, but at a markedly increased cost. What could have been a paying property is changed into a cause of worry, anxiety, and disgust to owners, manager, and men. It is like overloading a pack-mule; you kill your animal, and don't reach your destination. In this poor simile your mine is your pack-mule, and your destination is that desirable thing,—a dividend.

We have improved upon the Greeks and Romans in mechanics, but not in intellectual calibre. The old Latin proverb, *festina lente* (hurry slowly), or, as the Italians have it, *chi va piano va sano*, is most applicable to mining enterprises. It would be better for the capitalist who is about to invest in mines to call in the services of three men. First, the engineer, who reports on the mine; then, granting that the report is a favorable one, let him call in a mining superintendent, whose profession, whose specialty, is the management of mines that engineers have reported on. Either might be sufficient, but it is wiser to employ both. The nature of his past work has made the manager the very crystallization of conservatism. He it is who makes the autopsy. There is another safeguard to the investor in that the superintendent having to manage the mine will be cautious in his estimates of production, as he will have to prove his report by his results. If both reports are favorable, then let an average sample of

the ores produced by the mine be sent to some central point, and, upon the advice of the engineer and superintendent, let these samples be divided and sent to different metallurgists. For instance, in the case of certain silver ores, we have three methods of reduction, tried, known, and valuable,—roasting and pan amalgamation, roasting and leaching, and concentration and sulphid smelting. The technical and practical experience of the engineer and superintendent, added to the good business sense of the investor, should be able to decide upon the process to be employed with a much smaller chance of error than if a less careful proceeding were employed. We may consider that we now have the mine chosen. The method of beneficiating the ore decided upon, the superintendent begins his work. He first chooses his mine foreman, whose work he directs and with whom he consults. Sometimes this foreman is taken out of the mine and made foreman. Sometimes he is one who has been foreman at other mines. He is always chosen for his experience, ability, and force of character, and frequently and deservedly becomes a superintendent. It sometimes happens that he is a man who has had a preparatory education for his work, in school. While it is not desirable to disparage a prior technical training for the position of foreman, it must be confessed that it is preferable to have a man who has risen from the ranks, so to speak. The superintendent has then the advantage of natural selection. If all the men who work in mines were to have a technical training between the ages of twelve and eighteen, then the superintendent would be able to select as foreman a man of education, and still have what has been found desirable,—a "boss" for the men whom they consider one of themselves.

When a man is taken out of a mine and made foreman, there comes upon the men a reserve, a feeling that he is above his fellows and superior, but still one of them. They cannot hoodwink or deceive him, for he has "polished the head of a drill" in times gone by as well as they. He knows all the tricks, and there are many of them. They take pride in him because he has been one of them and has risen, and respect him because of his rise. It is well that a manager whose training has been largely theoretical should have associated with him a man whose training has been purely practical.

In large works where the mine is an extensive one and the plant a large one, and where the storehouse and office work require a share of the manager's time, a mill foreman is necessary. With free ores, the mill man should be able to get a large amount of rock through the battery, and generally a battery feeder is chosen for the position; but with ores that have to be roasted, concentrated, leached, or smelted, a man of a higher grade, a man of education, is needed,—one who has

made a study of metallurgy and whose experience has been in the line required. Such a man is more expensive, but in return he does better work, and the results obtained compensate for the larger salary. Managers who have not been graduated from some mining school, as well as some who have, are sometimes chary of calling a specialist to their aid. They are afraid of being supplanted. This is a great mistake. The better the subordinates, the more will the results redound to the credit of the executive head. Let such superintendents remember that executive ability is born in a man, and cannot be instilled; *poeta nascitur non fit*, or, as the French more wittily have it, *On se fait cuisinier, mais on est né rôtisseur*. It is the rarest of things to find a specialist who is a good manager. (The reverse naturally follows.) The metallurgist generally sacrifices everything else to the success of his specialty. He would not be a successful metallurgist otherwise. Concentration of thought on one thing is necessary for his success. On the contrary, the managing mind is one that superintends all things, that has the all-seeing eye, that brings many things into cohesion to the successful end of paying dividends. The manager should employ the very best staff procurable, if not from honesty, at least from policy, for the results redound to his credit, and the staff is rarely heard of.

An eminent metallurgist, who has made the reduction of gold and silver ores a life-work, not long ago wrote to the superintendent of a famous Mexican mine, stating that he had heard that their percentages of recovery were such as could be materially improved upon, and offering to make experiments at his own expense, after which, if he found that he could make an improvement, he would contract to make such changes as would be to the advantage of the company. The superintendent knew the metallurgist, knew that he had made improvements to the substantial advantage of other companies; and yet this was the answer the metallurgist received:

"If I were to bring about any improvements now, I would be blamed for not having done so before."

Possibly such a man is more fool than knave. It would take a bullion scale to determine which. At no expense to his company he could have had the experiments made, but he refused because he might lose his place and hence his salary. He evidently cared nothing for the welfare of the men who trusted him. He has been discharged.

In the writer's opinion, the western superintendent is the equal of any, and the superior of most, in that branch of his profession. The man in the region from Colorado to the Bay, from Alaska to Panama, is not tied down to any past. From whatever mining school he comes, or even when from none, he takes up his task with the deter-

mination to work and win. He has performed and seen autopsies and is conservative. Constantly among new things, he has not in his fibre the belief that the old ways are the best ways. He is not satisfied to let well enough alone. If he is getting 80 per cent., he is constantly on the alert to get 85 per cent. He has no prejudices. He works a mixed crew. He chooses the best men, regardless of their birth; he thus avoids combinations to steal, to shirk, to strike. A mixed crew rarely coalesces. There is a decided and well-known advantage in mixed crews. He overcomes difficulties more easily. He has been where supplies are scarce and slow to come. He has a knowledge of expedients. If he has not what he needs, he makes shift of what he has. Things must be kept going. He builds his house the last thing. He sleeps in a tent under a tree, and writes his letters on a candle-box. The beautiful and the comfortable are secondary considerations, to be thought of when the mill is built, when bullion is produced. He is for the company, morning, noon, and night; for his own comfort last. A species of professional patriotism. What is best for the company is his religion, his life. He trusts in God perhaps, but keeps his fire-hose in good condition. He rips out an oath once in a while, wears overalls, looks a bit rough, and keeps his patent leathers and his knowledge of the classics for when he "goes below," as the saying is in Nevada, when one is going to San Francisco.

A manager's tools are his men. What the hammer and anvil is to the blacksmith, the lathe to the machinist, the hammer and drill to the miner, the men are to the manager. A knowledge of men and methods is a requisite of more importance than technical knowledge. He can employ technical ability, but the "knowing how" to manage men must be his own, personal, innate attribute. An instance to the point will best explain.

The manager of a mine in the heart of the Sierra Madre Mountains, republic of Mexico, distant fifteen days' travel from San Francisco, without telegraphic communication, had a very difficult ore to treat. Not a metallurgist himself, having had no laboratory training, he was forced to depend on another. The man he had in the assay office, one by training and ability superior to the ordinary routine of assaying, was engaged on some experiments of considerable importance, which subsequently saved several thousand dollars a year to the company. His discharge would mean a delay of at least a month in getting another man, with the further delay of beginning the experiments all over again, besides a cost to the company of $150 for travelling expenses. Such were the conditions one morning when the manager, making his daily first round, entered the laboratory with his polite, suave "Good morning, X——."

The chemist, like many men who work before fires, was irritable to a degree, crotchety, and, when flaring, sometimes insulting.

"I don't want any blankety-blank, blank of blank manager come around bothering me," answered the assayer, in a flare of irritability.

"Very well, Mr. X——," returned the manager, "you'll hear from me to-morrow morning."

It was well known to the manager, as he had studied men, that those given to sudden outbursts regret them almost immediately, and suffer by anticipation from the consequences that may ensue. To be insulted by an employee and not resent it would endanger discipline. To resent it by knocking the man down, getting into a fight, and then discharging him, would have brought on the evil consequences of delay above mentioned. He heard during the day that the chemist expected to be discharged and had remarked "that he didn't have a cent, had forwarded his check to his wife, was a d—d fool anyway, and could never hold down a job."

Next morning, at his usual hour, the manager entered the laboratory, holding in his hand a letter. The trembling chemist rose to receive him He hadn't a cent, owed money, would have to borrow more to get away. The future yawned before him; he saw his dependent wife undergoing again the misery of want.

"Mr. X," said the manager, "who is the 'blankety-blank' this morning?"

"I am. My God! I am," answered X.

"Very well," said the manager, "this letter need not be sent: go on with your work." And he walked out.

The office-boy had been present at both interviews, and the story leaked out, with the result that discipline was more than maintained. By policy, or by a sense of humor, as you will, the manager retained a man who at that moment was valuable to the company.

In managing a mine accessible at all times to a base of supplies, the difficulties are very few, when the affair is in the hands of a capable man. Shoveling snow is a job to a fool. Only such mines as are hemmed in by snow for four months in the year are difficult to conduct in the United States, strikes and technical difficulties of course excepted. Strikes are frequently allowed to come to a head when the superintendent lacks diplomacy or the manager good common sense.

It is in foreign countries like the Spanish Americas, where diplomacy is most lacking, that a clash with the authorities is most dangerous. According to the writer's experience, there need not be a clash, especially in Mexico, where courtesy, politeness, and an appreciation of the Mexican's many good points, go a great way. If social methods do not remove the difficulties, then a job at a dollar a

day as Velador to the Jefe Politico's wife's second cousin, or other methods equally simple, will bring about harmony and sometimes save interruptions and money. In Mexico, under the able management of that remarkable man Diaz, there is safety for life and bullion. No trains are held up; no bullion trains are stopped; there are no strikes: and, with the mintage tax off, it would be a better place for mining than the United States, except in those localities where distance from a base makes supplies expensive.

While it would be well if the superintendent knew all that is to be known about metallurgy in its varied and far-reaching branches,—about geology, about mechanical as well as electrical engineering and hydraulics,—this is not possible: the human mind is not capable of so much, and what is required of him in its stead is the ability and the knowledge requisite in order to see what are the mechanical, metallurgical, or electrical necessities of his case, and, when the difficulties are above the ordinary knowledge of a mining engineer, to know what specialist to call upon. And for this reason, and to assist the superintendent, it would be well for all companies to supply their managers with such publications as treat of the mining and reduction of ores, even remotely. The important ones can be counted on the hand. THE ENGINEERING MAGAZINE (monthly), *The Engineering and Mining Journal* (weekly), *The Scientific American* with supplement (weekly), all of New York, and *The Mining and Scientific Press* (weekly), of San Francisco. There are other foreign and domestic publications of decided value. The expense is small compared to the gain to their men, and there can be no doubt that most companies would be willing if the matter were brought to their attention, the superintendent hesitating to do so. One may ask why the superintendent does not procure such publications himself. In many cases he does. In other cases, where his pay is small and his family large, he very foolishly economizes in the direction in which he least ought to. A constant and alert attention to the improvements that are going on in the world is a duty that he owes to himself and to his company. He hesitates to put out the money, because his term of office is uncertain, or from a penny-wise policy, or for some other reason equally controvertible.

In conclusion, let the manager always bear in mind that a reduction in expenses is equal to so much more bullion produced. When he can decrease the one and increase the other, his salary should be raised.

The yearn of the superintendent is heard over the land.

CAUSES OF FLOODS IN WESTERN RIVERS.

By Charles B. Going, Ph. B.

WHEN the sun, working higher and higher toward the north from the winter solstice, brings a January thaw over the Appalachian mountains, and the spring storms, fresh from the warm Gulf and chilled to find winter still reigning in the land, gloom and sulk over the central valleys and northern hills, little rivulets of snow- and rain-water gather from a thousand ravines and mountain-slopes and hurry downward to the sea.

Their upper courses, whether they be turned east or west, are much the same. Stained with gravel, burdened with drift, the current leaps along in the recklessness of youth, here robbing a farmer of stock or fences, there making sport with a bridge or working mischief with a turnpike or railroad: but, when the brook has become a river, if it be an eastern river, its turbulent childhood seems to be subdued to the staidness of the surrounding civilization. It sweeps soberly through the cities, mindful of boundaries, respectful to property rights,—a creature of law and order.

To the larger eastern cities and towns a flood would be considerably more astonishing than an earthquake. Imagine, if you can, a water famine in Poughkeepsie occasioned by the drowning of the water-works by the Hudson; conceive of the situation in New York, if the roads entering the Grand Central Depot were landing passengers at One-hundred-and-tenth street, because there was three feet of water on the depot floors: figure to yourself the suspension of traffic between Philadelphia and Baltimore because the Delaware was out of its banks and stretching a mile or so into the bordering country. Yet on the western side of the mountains such things as these happen almost annually: in Pittsburgh and Cincinnati, in Louisville and Chattanooga, in New Orleans and the whole western river country, the spring flood is a yearly menace and a frequently-recurring disaster. Business is impeded, tracks are flooded, traffic is embarrassed, loss and destruction are suffered spring after spring, because rivers which in August and September fall so low that the steamers can no longer drag their keels over the sand-bars, in late winter are frequently so high that boats, even with their funnels lowered, cannot pass under the lofty bridges.

A state of affairs which in New York or Boston would recall the days of Noah and weaken faith in the promise of the rainbow is in Cincinnati or Louisville considered merely an unfortunate, but generally necessary, "February flood": but even in the west, we are told, these

disasters are becoming more common. The ancient steamboat-man remembers that the river used to be less wildly irregular and navigation more continuous: the oldest inhabitant asserts that "the climate is changing."

All sorts of explanations are offered. Some attribute the entire difficulty to the Mississippi levees; others gravely affirm that the trouble is wholly due to the erection of a few bridge-piers; we are solemnly assured that an encroachment of a few rods on the channel by a waste-pile at a coal-yard or sawmill is responsible for the flooding of two thousand miles of valley above and below the obstruction. "Snow in the mountains" still cries lustily for recognition as the sole and only cause, though the past decade has witnessed many floods coming when there was no snow at all in the mountains, and the anomalous fact would always assert itself that snow on the eastern slope did not produce parallel results.

In truth, the phenomenon must be attributed to the conjunction of a number of causes, of which the first is topographical. Glance for a moment at a map of the United States, and notice the striking difference between the drainage systems of the eastern slope and the central basin. The former, with a total area of less than 250,000 square miles, is divided by the buttresses of the Appalachian chain into many valleys of limited area, each served by a distinct and separate drainage channel. The Hudson, the Delaware, the Susquehanna, the Potomac, the Rappahannock, the James, the Roanoke, the Santee, the Altamaha, the Savannah, and a multitude of smaller streams independently discharge the eastern rainfall into the sea, most of them through channels of abundant size,—channels which are in their lower courses practically arms of the sea, carrying up tide-water to receive the mountain streams a hundred miles or more from the ocean, and offering an enormous factor of safety in case of any unusual demand upon their capacity.

On the western side of the mountains the condition is very different. With five times as large an area to drain, the number of discharge channels is so reduced by repeated confluences during their meanderings in the alluvial plain that (with the exception of a few minor southern streams and inconsiderable outlets to the great lakes) the entire rainfall draining from the States between the mountains and the Mississippi must be carried by the Ohio river; and the entire basin from Appalachians to Rockies, from the watershed bordering the great lakes to the northern boundary of Texas, must depend for outlet upon the Mississippi river, with a bed smaller than almost any one of the more important eastern streams. At New Orleans, for example, it has a width of 2400 feet. The drainage area above this point is about 1,200,000 square miles: the Potomac at Washington, with a width

of 2380 feet, carries the drainage of a basin of only about 15,000 square miles.

A deluge from the deep snows of the Alleghenies is so divided, on the eastern slope, between all the rivers from Pennsylvania to Georgia that the citizen of the coast-towns knows of it only as a chance newspaper paragraph; but the merchant in the Cincinnati "bottoms" will, within a week, have that deluge gathered from a hundred creeks and delivered on his warehouse floor. A month later the dweller in New Orleans watches it fearfully as, joined to the flood from melting snows in Minnesota or the Rockies, it laps the crest of the levees.

The second main cause is geologic, and lies in the impervious character of the soils and underlying strata of the interior basin. As the mountain-ridges die away into the central plains, the folded sandstones, schists, and other porous rocks give place to flat, unfaulted limestone strata, and the clean, deep gravels are replaced by solid clays. The rains which on the whole eastern slope tarry in lakes, or find ready percolation down into subterranean pockets, whence they may filter forth gradually in a thousand springs, on the western side are almost entirely shed from the surface, and there is much less bountiful provision either of surface or underground reservoirs to absorb excessive precipitation and equalize its discharge into the rivers. The result is that a rainfall which might take weeks or months for distribution to its many channels to the Atlantic will in fewer days be sweeping in a flood-wave down its limited roadway toward the Gulf.

The third great cause is climatic: for to a far greater degree westwardly than eastwardly the year is divided into a rainy and a dry season. Not so much that the total rainfall is greater, although this is true in regard to the immediate basin of the lower Mississippi and Tennessee rivers, in which fall the heavy rainstorms caused by the impinging of warm, "low" areas from the Gulf upon the cold air of the north-west.

In this region is the largest area in the United States showing a mean monthly rainfall of over six inches: but even more important in its influence is the concentration of the precipitation in a limited portion of the year. While Atlantic coast stations, in the average, show a pretty close approximation to a uniform rainfall the whole season round, the districts of the Mississippi, Missouri, and Ohio rivers vary from barely 2 inches per month in autumn to about 5 inches in late winter: and the excessive precipitation comes just at the time when an accumulated snowfall is likely to be liberated by spring thaws. Waterways which would be adequate to an enormously increased discharge, if the flow were constant, are overtaxed for two months, and perhaps soon after dwindle into insignificance.

A CONDITION WHICH IN THE EAST WOULD RECALL THE DAYS OF NOAH.

SO HIGH THAT BOATS CANNOT PASS UNDER THE BRIDGES.

IN THE BACKWATER.

It may be that the oldest inhabitant is right in asserting that the season used to be more equable; it may be that man is partly responsible for this increased irregularity; but certainly he is wholly accountable for a remaining cause of floods, the artificial element which emphasizes and heightens all others. This is two fold,—deforestation and drainage. Not only has the lumberman's axe stripped the hillsides of the forest whose cover retarded the rapid thaws, but the farmer has felled acre after acre of timber which once afforded a deep absorbent bed of leaves and myriad tiny pockets for the retention of the rain; and, even where some wood pasture has been preserved, it has been thinned and cleared of all the undergrowth whose interlacing roots checked the rapid surface rush of the rain.

Thousands of square miles, once covered by the vast natural sponge of the forest, now spread to the sky a bare surface of hard clay, shedding water almost like the roof of a house; and every little boggy spot, every hollow where the water collected and stood through the spring, has been ditched and drained in the frantic effort to gain a few more rods for the growing of wheat. Miles upon miles of tiling underlie the land; ditches rival canals in extent and magnitude, rushing the rainfall into the streams, getting rid of water as if it were a curse,—and this in a country where almost every summer the wells run dry, and for weeks the farmer hauls water for his house and his

LOW WATER.

MEDIUM LOW WATER.

stock, while his corn burns in the field and he cries to heaven to break the drouth.

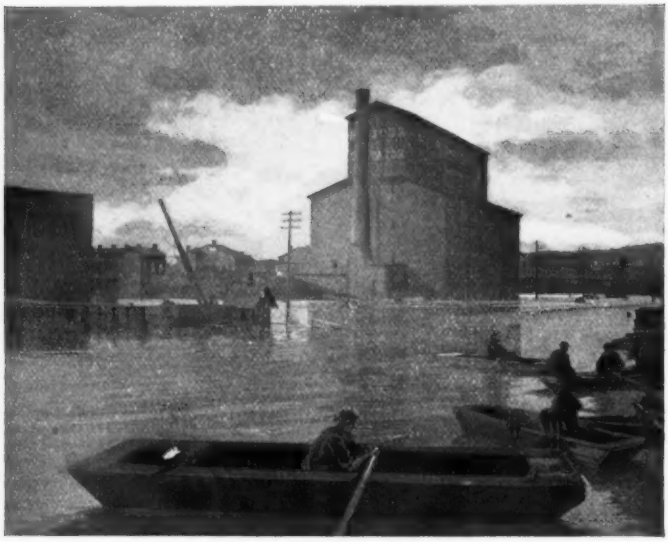
From the great tracts of recently reclaimed "marsh" which, almost bordering upon the great lakes, yet are drained into the headwaters of Ohio tributaries, down to little swales and ponds pocketed in the southern hills,—everywhere, with axe, ditch, and under-drain, the dweller in the land has been feverishly busy exaggerating topographical dangers, quickening the soil's too great tendency to shed the rains, heightening the evil effects of the seasons' inequalities, until, in a region where the annual rain-fall is over 40 inches, an adequate water-supply the year around is hard to obtain; and a city which sees the river rioting through its streets in early spring cannot find in the same stream a sufficient volume of flow to secure a supply of wholesome water for its citizens in the late summer.

The components in the problem, then, appear to be four: peculiarities of topography, difficulties of geological formation, defects of climate, and delinquencies of man.

Diagnosis, however, is only useful as it affords suggestions for relief. The crying need is not for an answer to the question: "Why do floods occur?" but to the more practical one: "How can floods

THE CINCINNATI MERCHANT HAS THE FLOOD DELIVERED ON HIS WAREHOUSE FLOOR.

FEBRUARY FINDS THE RIVER RIOTING IN THE STREETS.



RAILROAD TRACKS ARE FLOODED.

be prevented?" and we may at once answer: "*Not* by control of the main streams." It would be as easy to control an exploding boiler or extinguish the forest fire which is sweeping half a State. But the management of the tributaries would be an affair of much less difficulty, and perhaps a feasible undertaking. Their extreme rise, even in the more important and navigable lower reaches, rarely equals 20 feet; their flood planes are limited and, on account of the frequency of their overflow, not extremely valuable.

It would not seem impossible to devise a system of dams and locks by which the greater portion of the freshet in the minor rivers could be retained in great semi-natural reservoirs, and an important double purpose thereby be served: first, the avoidance of the successive discharges of tributary flood-waves upon the very crest of the flood-wave in the main channel,—the condition by which disastrous freshets in the great cities are now generally occasioned; second, by the gradual liberation of the stored waters, the maintenance of a navigable stage in the principal stream for a much longer season than the present average.

The scheme seems a daring one, but is most strongly advocated by Mr. C. Ellet, Jr., in his work on the Ohio and Mississippi rivers. He finds no important engineering difficulties to be overcome, and con-

siders cost unimportant in comparison with the enormous resultant saving and gain.

In considering the suggestion, it must be remembered that it is not the entire freshet which must be penned up, but only that portion of it which causes the last disastrous rise. In the Ohio at Cincinnati, for instance, a rise of fifty feet does comparatively little damage; it is the additional ten feet, raising this stage to sixty, that change an inconvenience into a calamity.

But perhaps the most really feasible amelioration is to be found by going still further back,—to conditions affecting the watershed itself. Reforestation, such as that suggested by Mr. Gifford in his admirable paper on "Forest Fires," in THE ENGINEERING MAGAZINE for November, 1894, would exert a marked beneficial influence; for, apart from the much debated effect on climate, every little forest patch would be a natural reservoir, retaining the water in its deep mould, retarding with its roots the rapid surface wash, and to some extent checking by its shelter the unduly rapid thaw of the snow. And, in the replanted timber and that now standing, let the natural undergrowth come up again: for, apart from any consideration of preservation of flora and fauna (aspects which the practical farmer might

TRAFFIC IS IMPEDED.

AN ANNUAL INCIDENT OF THE COAL BUSINESS.

HAVOC IN THE LUMBER YARDS.

consider foolish sentiment), its destruction, as Mr. Gifford ably shows, is bad husbandry, worse forestry, and worst of all for conservation of water-supply.

But perhaps most is to be expected from a readjustment of the artificial drainage system. If the farmers, warned by repeated burning drouths of past years, would but recognize that water is a commodity of inestimable value and least procurable when most needed, but to be had for the gathering if sought in time,—nay, that it hardly needs to be gathered, but will collect itself, if the most simple means be provided; if, instead of hurrying the precious spring rain off the land, every man or each small company of neighbors would store some of it, at least, *on* the land,—they would become wise conservators, not only of their own best interests, but also of the property and safety of dwellers along the streams hundreds of miles below them.

There need be no interference with the reclamation of swamp grounds; but the water should, wherever possible, be gathered into small reservoirs, instead of discharged directly into the nearest stream. The expense would generally be less than that required under the present plan; the sacrifice of land would be trifling—perhaps no greater than that now required for ditches; but in any event, with wheat bringing less than 50 cents and three crops in his barn, the agriculturist of the central States might perhaps afford to spare an acre or two of his wheat land, especially if by so doing he could protect the

THE BUSINESS OUTLOOK RATHER CHEERLESS.

rest. For, in many cases, with but small expense, a simple irrigation system could be devised in connection with the small reservoir scheme, and many a precious crop, which now burns in the ground, could be saved through the conservation and application of the rainfall to its natural use,—the refreshing of the earth throughout the year.

The possession of a small pond on the farm could also add materially to the comfort and the income of the owner. It might provide a supply of ice sufficient,—not only for his own use, but for sale.* It would water his stock the year around, to the saving of his time, his muscles, and his well. He might add ducks and geese to his barn-yard fowl, or, without expense, indulge in the luxury and incidental profit of a private fish-pond: and his kitchen- or market-garden, if he have one, would be saved from the destruction which now so often overtakes it when the well runs dry and it is barely possible, even with long hauling, to procure enough water for the stock and for domestic use.

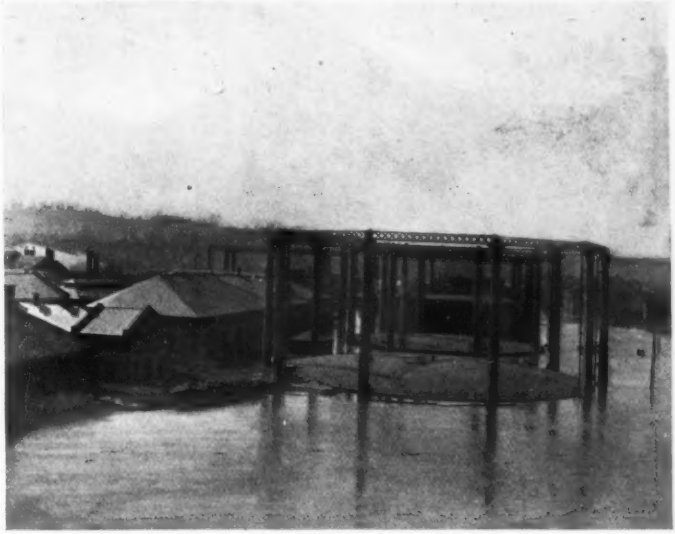
In these multiple small reservoirs, it seems to me, lies the greatest and speediest hope. The plan has not the scope of Mr. Ellet's stream-control, in that it offers no possibility of subsequent maintenance of a

* A foot of ice on a pond 1 acre in extent is about 1100 tons.

navigable stage in the rivers; but it would perhaps deal quite as efficiently with that sudden overwhelming excess of precipitation which furnishes the highest and most destructive element of the flood.

It would, at all events, work most harmoniously with Mr. Ellet's plan in checking the highest winter freshets, and it would in no way diminish the summer volume of the rivers, which is derived from deep drainage and not from surface flow. The beauty of the arrangement is that it would directly and munificently reward those who put it into effect, and that each particular enterprise would call only for individual decision and would come within the reach of private means, while the larger system of control would be almost or altogether a national undertaking, requiring a public appropriation and no doubt arousing a powerful organized opposition. It may and probably will come—"some day": reforestation and readjustment of drainage can begin *to-day*.

Geologic formation cannot be changed; climatic conditions are to be altered slowly and slightly, if at all; but the effects of topography can be enormously modified by a conjunction of minute changes, and the defaults and errors of man's work can be corrected, until such a paper as this shall be no longer possible, because there will no longer be any "Floods in Western Rivers."



THE GAS WORKS FLOODED.

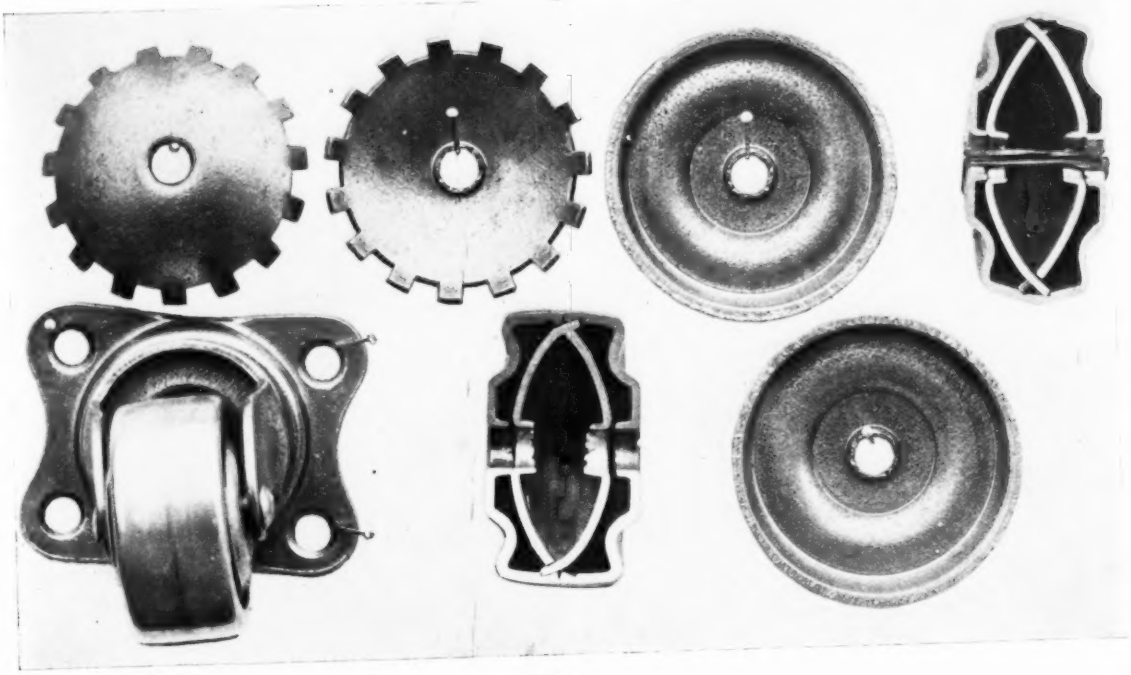


PLATE I.

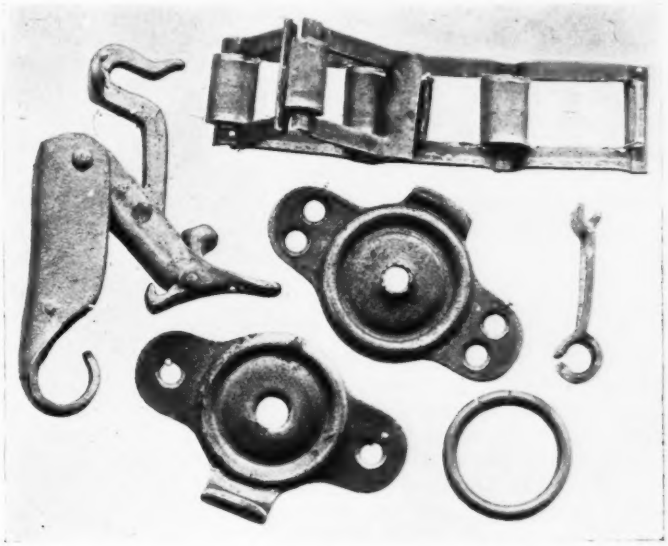
THE CONQUEST OF STEEL OVER CAST IRON.

By Horace L. Arnold.

THE constant improvements in steel manufacture, and our vast natural resources in the way of ore and coal, coupled with the eager competition of steel makers in search of a market for their product, have brought the price of wrought steel in the form of superbly-finished round bars and plates to such a point as to give the manufacturer of small metal wares a new constructive material.

Until within a very few years the manufacturer who wished to increase strength and decrease weight in the very large line of manufactures sold to builders, house finishers, and housekeepers by the substitution of wrought metal for grey iron was confronted at the outset by an almost prohibitive increase in the cost of structural material.

So great was the difference in price between what was known as "Norway" iron in the sheet and small castings that the manufacturer, although well aware of the advantages in many cases to be gained by commencing his operations with metal in the sheet rather than melted



B C D A E

PLATE II.

PLATE III.

plate could be had at from 9 to 12 cents per pound in lots of from 500 lbs. to a ton; and "gun rods" from, say, 4½ to 6 cents. But, with wrought-metal at these prices, grey iron was the cheaper material. Now bright steel strips rolled inside a five-hundredth limit can be bought for 2¼ cents, and a rod drawn to within a thousandth limit at a correspondingly low rate. These materials are even better than the old "Norway" and "Juniata" irons, and can be cut, formed, and cold forged into the most fantastic distortions without loss of strength. This new material, made a new factor of economical production by its low cost, is steadily displacing foundry work in small manufactures, as steel beams have already almost entirely displaced cast-iron columns in building structures.

iron in the founder's ladle, and by continuing with the punching press, drop hammer, and tumbling barrel rather than the moulder's flask, the pickle tub, and finishing tools constantly destroyed by the hard edges of small castings, was forced, if he wished a better result than could be obtained from rough parts, to unduly reduce the weight of the sheet-metal production to meet the selling price of the grey-iron article. Stripped and pickled "Norway"

PLATE IV.

There can be no question as to the superiority of our small grey-iron castings. We have perfected the art until the every-day output of some of our foundries has as fine a skin and is as perfect in minute details of outline and ornament as the German cast-iron jewelry so long celebrated as the finest example of the moulder's product. At the North Cromwell foundry, for instance, between Hartford and Middletown on the Connecticut river, the work reaches such a close approximation to perfection in the points of uniformity of size, smoothness of surface, perfection of outline to the entire exclusion of fins and sprue marks, and uniform texture of metal, as to fill every requirement in the way of assembling and finishing the extremely ingenious and often quite complicated toys which are the principal product of that picturesque and peaceful hamlet, the name and existence of which are hardly known outside of the dealers in its wares. Not only do we produce grey-iron castings which are fine and perfect, but we make them at an extremely low price. The North Cromwell foundry ships such wheels as are put under the familiar tin toys to the German and French toy-makers. These wheels are marvels of delicate casting, from a hundred to a hundred and fifty wheels to the pound according to the size, with a hole drilled accurately in the centre of each wheel. These were sold in the times of our highest prices at 11 cents a pound. All of this work is hand-moulded, and one boy will put up a hundred or a hundred and twenty snap flasks for a day's work, each containing twelve mop-head parts with a large core in every piece, at a wage of 75 cents or $1.00 for the moulding of the entire twelve or fourteen hundred pieces. With such a low labor cost and such perfection of product, it is not a matter of surprise that manufacturers of small articles should naturally turn to castings as the cheapest and best material for the basis of their product.

In the important class of locks and hinges our grey iron castings revolutionized the methods of manufacture, and overcame the prejudices in the minds of users against the fragile material, grey iron, as compared with the wrought-metal structures previously in exclusive use. We are yet the producers of enormous quantities of cast-iron door-locks, the factories at New Britain, New Haven, and South Norwalk employing thousands of hands in fine factories in the production of really excellent locks, in which, curiously enough, the English and German lockmakers' choice of materials is exactly reversed; they made the lock-case and bolts of wrought metal, and used a cast-metal key, while we cast the case and bolts, and in a very large class of work even the lock-tumblers as well, but use a wrought-metal key, a flat steel key, which we first inserted in a cut in a barrel forming part of the lock to make it turn smoothly and easily, but later built up around the bit to secure a good turning action.

We made grey-iron castings much stronger, weight for weight, than had ever before been commercially known. To such perfection was the art of mixing and melting iron brought that our small grey-iron castings would bend a long way before breaking, and at the same time have great stiffness and elasticity ; so that we really make good durable work with our cast-iron substitute for wrought metal, which was, until quite recently, the final resort where the lowest cost of production must be had.

We have now, however, reached a market price for sheet steel, cut in strips to suit the purchaser's needs and rolled very accurately to thickness, which threatens the supremacy of grey iron as the chief factor in low-cost production of small manufactures. The utmost efforts of the foundryman fail to bring the price of fine castings to 2¼ cents per pound. Indeed, it requires extreme care in every detail to bring the first cost of fine castings, such as are used in locks, casters, and house trimmings, much below 2½ cents per pound. Although patterns are made and gated with the utmost skill, and used in connection with snaps and matches of incredible convenience and perfection, so that the patterns "jump out of the sand themselves," as moulders express their easy and perfect leaving of the flask, there are still large and unavoidable expenses attending the production and use of small grey-iron castings. In spite of the best efforts of the melter, there is a considerable percentage of loss of stock in the cupola ; no matter how diligently the riddle is used, there is another small loss on the floor ; and, though the sand is so fine and the skin of the casting so perfect that the work comes almost clean when shaken out, it must all be handled over the wheel and through the tumbler. Patterns are expensive, and must be kept up ; oil matches require some attention ; and there is a far higher grade of handicraft skill required of the moulder than of the rolling-mill hand and press feeder. All of these small factors unite to prevent the reduction of the cost of small grey-iron castings much below that obtained with present methods, so that, with sheet steel at 2¼ cents per pound, and our present skill in die-making and the very great excellence of our presses, it is doubtful if any small wares can be made more cheaply in grey iron than in steel.

At first sight this proposition seems absurd. Grey iron lends itself so readily, through its fluid condition, to the acquirement of any desired shape that the mind at once turns to that material when an article of complex figure is presented for construction. A ladleful of melted iron fills the intricacies of a properly-prepared mould with no greater power requirement than is furnished by ever-present gravity, and demands no greater resistance to confine it during the forming of its

contour than is afforded by the loosely-cohering sand of the mould; sheet steel, on the contrary, offers very great resistance to changes of form, and the shaping of it requires powerful machines with tools and forms of tempered steel to give and resist the effects needed to force this stubborn material into the thousand various complicated shapes demanded by small metal wares for general use.

In many cases, however, there is not much in cost of plant in favor of the casting. The patterns may cost, for the grey-iron work, as much as, or even more than, the punch and die work for the same piece in sheet steel; and, from this point of first cost of plant, the cost is all in favor of the sheet steel, because the mould for the grey-iron work must be made anew for each individual piece produced, while tens and hundreds of thousands of pieces may be produced in sheet steel from one set of dies. Again, the very cheapest labor can be used to advantage in punch and die operations, while the grey-iron moulder, even on the simplest work, must be skilled and must exercise his skill, and, while the moulder may produce in extreme cases, say, 150 "snaps" per day, each containing possibly 50 or 75 pieces, making a total of from 7000 to 10,000 pieces per day as his extreme production, the press hand may make as high as 150 operations per minute, which would give an extreme result of 90,000 pieces in a day once through the press; and, where large quantities are produced, automatic feeds are substituted for hand feeding of the presses, so that in the cutting rooms, for instance, of some of the Waterbury brass mills one man and a boy keep a large number of presses in constant operation, at an expense so small as to be hardly appreciable for each piece cut.

Nor need these press operations be simple in their results.

Hitherto mention has been made only of the press or punching machines as a factor in wrought-metal shaping, but within the last few years the header has had its blows increased from one to two or three in a cycle, and cold forging by means of light quick blows has been brought to a point of perfection which gives it unlimited powers in seemingly widely differing directions. To these may be added the riveting machines for cold work, also operating on the general plan of very light quick blows, which move steel in any direction and to any extent without hardening the metal; indeed, the effect of the cold forging seems to be to anneal the stock, so that tool steel drawn out in the cold forging machine may be tied in knots drawn up close without a sign of fracture.

With these aids at hand, and with perfect stock of any width and thickness,—or, if round, of any length and diameter,—the supremacy of grey iron for small manufactures is not only threatened, but has

already, in important lines of manufactures, been attacked and overthrown.

A few examples may be instructive to those who have not considered the matter of wrought-steel uses in small manufacturing.

A caster for use under furniture is one of the articles inseparably associated in the mind of the hardware dealer with the use of cast metal as a material. The strong fork and the substantial wheel certainly seem more suitably constructed of castings than of any possible shape into which sheet-metal can be distorted: yet that such is not the case is very clearly evident from the example in plate I, which shows a sheet steel caster and the construction of its sheet-metal wheel, made by the Standard Caster and Wheel Company under the direction of Mr. E. G. Hoffman. This caster is chosen as an illustration of the new uses of sheet steel, because a caster, from the shape of its wheel-fork and wheel, would seem a very unpromising subject for improvement by the substitution of press work for foundry work, and because of the consequent very high degree of constructive talent shown in this commercially successful change. The general appearance of the complete caster is shown in the engraving to be quite similar to a cast-iron caster with the broad-faced wheel which is essential to a good tread on soft material; the view given does not show the ball bearing, which makes this caster swivel with an ease hitherto unapproached. The construction of the wheel is particularly ingenious; all the parts are shown, and also a section of the wheel members assembled for closing, and a sectional view of the closed wheel. This wheel is made of four pieces: two cups, which are placed mouth to mouth to form the outer wheel surface, are internally grooved close to the edge in their single forming operation, and the two fifteen-toothed dished inside supporting plates interlock with each other and with the grooves in the outer wheel-cups, as clearly shown in the assembled parts section. In this form the wheel is placed at the mouth of a tapering die, through which it is forced by a single stroke of the press, with the effect of reducing both the flare and the outer diameter of the cups permanently, and thus causing the teeth of the interlocking internal supporting plates to grip the internal flanges of the cups and unite them firmly, while the internal supporting plates are at the same time put under a permanent compression load, which makes them very strongly resist deflection effects caused by the face of the wheel travelling under a heavy load over resistances of limited area. Despite its small size and humble use, this Hoffman caster wheel must justly rank among the finest examples of sheet-steel construction; it is difficult to determine whether the simplicity of its construction methods or the ideal stress conditions of the finished article should

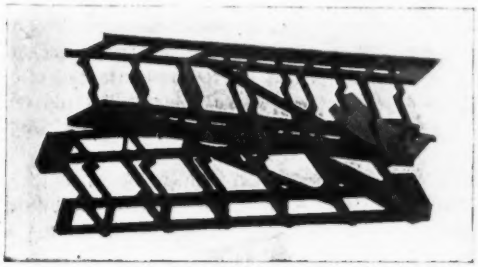


PLATE V.

most command admiration. As to the whole caster, it meets the old cast-iron article in price, while its vast superiority at all points of value has already given it an almost exclusive demand among large users.

Plate II shows articles produced in Brooklyn, N. Y. The French were the originators of the drawing press and the vast line of manufactures which depend on the use of that tool, and Mr. C. F. Vieillard appears to be endowed with the racial aptitude for manipulating sheet metals in a very marked degree. An evidence of his ability is seen in the sheet-steel drive chain which enters the automatic cutting, forming, and assembling press, in the form of a steel strip of the width of the finished chain, and comes out in the form shown at A, with its weight unchanged, but tortured into the familiar form of the open-link drive chain, at the rate of thirty or thirty-five links per minute, a speed of forty links per minute being possible. Plates III and IV show a cash-register entirely of sheet steel, a substitution throughout (except the dial hand) of sheet steel for grey iron.

Plate V shows two ladder-like frames connected by a number of side links and held in certain relative positions by a long coiled spring. Two of these structures are shown: the under one is a cast-metal structure; the upper one is the sheet-metal substitute.

B, Plate II is a hame fastener of sheet steel.

C, D, and E are the top and bottom parts of a whiffletree plate and their contained intermediate ring, a sheet steel and wire substitution for malleable iron, as in the case of the hame fastener.

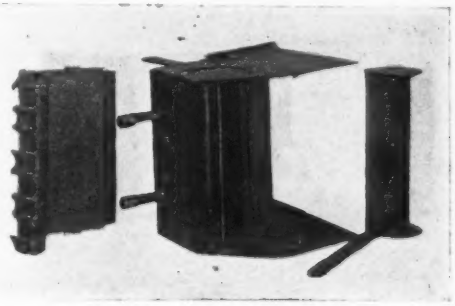


PLATE VI.

Plate VI shows

different views of the mechanism of the familiar "Stolwerck" coin-controled vending machines; these are comparatively large mechanisms, and apparently very suitably made of grey iron; the reduction in cost and the superiority of action obtained by replacing the cast iron with sheet steel were so great that the wrought-metal structure is now in exclusive use.

The caster wheel and the drive chain were selected as examples of elaborate results obtained by simple and highly instructive exhibitions of great ingenuity; the other examples may be said to be chosen at random from among thousands of articles which show that the change from grey iron to wrought steel is not confined to isolated cases. The change is organic, and cannot be otherwise than permanent. The American manufacturer who wishes to compete on the most favorable terms with the cheaper labor of other countries in the production of small articles must look to the Bessemer converter rather than to the grey-iron cupola as the womb of his work.

As to the weight-limit of the cold cut, drawn, formed, and forged piece, that is a figure which has not yet been fixed, and which may be expected to increase year by year for a long time to come. Simple forms of considerable size may be very readily made without heating the stock. The precise economical weight-limit for cold-made steel work, the exact point where heat can profitably be called in to lessen the cold metal resistances, must, it seems, depend largely upon the shape to be produced.

Of the dominant importance of wrought steel as a material in small manufactures there can be no question; and the establishment making most use of wrought steel must certainly be held, in the particular of choice of material, to have the greatest expectation of success.

ELECTRIC POWER IN SOUTHERN COTTON MILLS.

By A. F. McKissick.

THE development of the manufacture of cotton into yarns and cloth in the Southern States during the past fifteen years has been marvellous. Almost every town in the cotton-growing States has one or more cotton mills, and in many instances we find factory-towns springing up as the necessary consequence of the location of a cotton mill in an unsettled region. At first only coarse goods were manufactured, but now mills are being built for the manufacture of fine goods, in direct competition with the fine goods of the Northern mills.

The South has many advantages over the North in cotton manufacture, such as favorable climate, cheap fuel, proximity to cotton, cheap building materials, low prices for sites, water, or steam, lower rates of wages paid to a good class of help fast becoming skilful, longer hours per day, and more working days per year. The great advantages of the South for cotton manufacture have caused New England mill men to turn their eyes to the South, thus inaugurating the movement of the "mills to the cotton."

The development made in the manufacture of cotton goods in the South proves conclusively that she has the enterprise, the energy, and the engineering and mechanical skill to seize her opportunities. The South, during the past year, has increased her spindles over 250,000, the greater part of this increase being in four States,—*viz.*, the Carolinas, Georgia, and Alabama. The table on the next page, taken from the *Manufacturers' Record*, shows the growth since June, 1880, the figures for 1894 including enlargements of mills and new mills under construction,

The following table, also from the *Record*, shows the relative growth of the consumption of cotton in Northern and Southern mills since the season 1886–87 :

	Northern Mills.	Southern Mills.
1893–94	1,601,173	718,515
1892–93	1,687,766	743,348
1891–92	2,027,362	604,661
1889–90	1,799,258	546,894
1888–89	1,785,979	479,781
1887–88	1,804,993	456,090
1886–87	1,710,080	401,452

	June, 1880.			June, 1890.			Dec. 31, 1894.		
	Mills.	Spindles.	Looms.	Mills.	Spindles.	Looms	Mills	Spindles.	Looms.
Alabama	16	49,432	863	13	79,234	1,692	30	264,458	4,019
Georgia	40	198,656	4,493	53	445,452	10,459	69	592,764	13,522
Kentucky	3	9,022	73	5	42,942	677	8	54,088	748
Maryland	19	125,706	2,425	15	158,930	2,965	22	176,786	3,520
Mississippi	8	18,568	644	9	57,004	1,352	10	62,678	1,894
North Carolina	49	92,385	1,790	91	337,786	7,254	158	743,299	14,376
South Carolina	14	82,334	1,676	34	332,784	8,546	61	730,590	20,004
Tennessee	16	35,736	818	20	97,524	2,043	27	128,066	2,539
Virginia	8	44,340	1,322	9	94,294	2,517	13	120,444	3,483
Arkansas	2	2,015	28	2			5	16,640	220
Louisiana	2	6,096	120	2	66,980	1,726	7	55,132	1,495
Florida	1	816	.....	1			1	1,400	.....
Texas	2	2,648	71	1			14	77,514	2,385
Total	180	667,754	14,323	255	1,712,930	39,231	425	3,023,859	68,205

Up to the beginning of 1894 the power for cotton mills was produced either from steam engines or turbines. The question as to which should be adopted depended altogether on circumstances that varied for different cases.

In a great many towns and cities in the South the question of water or steam did not come up for consideration, for the reason that there was no available water power convenient. In order that a water power may be available, it must satisfy these conditions: (1) the volume of the stream and the fall must be sufficient to guarantee the amount of power required; (2) there must be railroad facilities; (3) the stream must have a sufficient water-shed to supply the volume of water needed through the dry summer months; (4) there must be a convenient and satisfactory site for a mill that will not require excessive excavations and foundations; (5) it must be possible to build the dam at reasonable cost. With an available water power, the facts to be considered in solving the problem of steam or water are principally these: (1) cost of steam plant, and operating expenses; (2) cost of turbine plant, and operating expenses; (3) difference between cost of excavations and foundations for the mill located at the water power and at the point where steam will be used: (4) transportation expenses to railroads.

With these facts ascertained, the question, then, is which is the greater,—the operating expense of the steam plant, or the interest on the difference between cost of erection of the mill building at the water power and at the point to be selected in case steam is decided upon, plus the interest on the difference between cost of the turbine plant and that of the steam plant, plus the operating expense of the

turbine plant. These are the main facts to be considered. The tendency of mill men in the South is to use water power, if possible; and there are many successful mills to-day using water power, which are located from one to three or even more miles from a railroad.

Electricity has developed to such an extent in the last few years as an agent for transmission of power that mill men have begun to realize that in some cases there are many advantages to be gained by its adoption.

The first case of adoption of electricity in the South as a means of transmission of power for a cotton mill is that of the Columbia Cotton Mills at Columbia, S. C. In this case the mere transmission of power is of trifling importance, as the distance is only a few hundred feet. The turbines in the power house are supplied with water from the recently-developed Columbia Canal, and, on account of the location of the canal at this point, it would have been utterly out of the question to use direct belt transmission from the turbines. The question, then, was whether to build the mill nearer the turbines and use rope transmission, necessitating, however, excessive excavations; or to place the mill where it is now located,—on a comparatively level site,—and use electrical transmission. The latter was decided on, and the mill started successfully in April, 1894, and has been running since that time without the slightest hitch.

This plant consists of two 750-h. p. generators direct-coupled to horizontal turbines, running at a speed of one hundred and eight revolutions per minute. This low speed was necessitated by the low head and the desire to dispense with the loss of efficiency due to belting. The line is carried in an underground conduit to the mill, and there is distributed in conduit tubing to the various floors of the mill, where are located seventeen 65-h. p. motors, suspended in an inverted position, so as to take up the minimum of space and permit of direct belting to the short sections of shafting driven by individual motors. These motors have no moving contacts of any kind, and regulate within two per cent. in the matter of speed. This plant is of great importance as exhibiting the application of electricity in the distribution of power in small units. There are no long lines of shafting in this mill, no large belts or pulleys, and each room is independent of every other.

As to the question of difference in efficiency between electrical transmission and transmission direct from turbines or steam engines by means of ropes or belts, it must be borne in mind that, when electrical transmission is used, the motor is placed where the power is needed, there are no long lines of shaftings or long belts connecting the shaftings of different floors, and, when direct transmission from turbine or steam engine is used, the whole system is made up of long lines of

shafting, connected by belts extending from floor to floor, thus involving heavy friction losses. Reference is made to the following table compiled by Mr. J. J. Flather, giving the names of firms, the nature of their work, total horse-power use, horse power required to drive shafting, and the percentage of total power required to drive shafting.

Name of Firm.	Nature of Work.	Total Horse Power.	Horse power required to drive shafting	Percentage of total power required to drive shafting.
J. A. Fay & Co.	Wood-Working Machinery	100	15	.15
Union Iron Works	Engines and Mining Machinery	400	95	.23
Frontier Iron & Brass Co.	Marine Engines	25	8	.32
Baldwin Locomotive Works	Locomotives	2500	2000	.80
W. Sellers & Co. (One Dept.)	Heavy Machinery	102.45	40.89	.40
Pond Machine Co.	Machine Tools	180	75	.41
Yale & Towne Co.	Cranes and Locks	135.05	66.81	.49
Ferracute Machine Co.	Presses and Dies	35	11	.31
Bridgeport Forge Co.	Heavy Forgings	150	75	.50
Hartford Machine Screw Co.	Machine Screws	400	100	.25

It will be noticed that the power required to drive shafting for these cases varies from 15 per cent. to 80 per cent., the average being 38.6 per cent. Mr. J. T. Henthorne, in a paper read before the American Society of Mechanical Engineers, states that the friction of the shafting and engine in a print-mill should not exceed 19 per cent. of the full power. Out of 55 examples of a miscellaneous character which he has tabulated, 7 cases are below 20 per cent., 20 vary from 20 per cent. to 25 per cent., 15 from 25 per cent. to 30 per cent., 11 from 30 per cent. to 35 per cent., and 2 are above 35 per cent., while the average of the total number is 25.9 per cent. Mr. Barrus, speaking of this subject, quotes 8 cases, the data of which were obtained from tests made by himself in various New England cotton mills, in which the minimum percentage was 18 and the maximum 25.7, the average being 22. At the Columbia Mills 85 per cent. of the power produced by the turbines is delivered to the shaftings, which, as I have said, are very short, have no large belts or pulleys, and, consequently, cause very little friction loss, so that we can safely say that the efficiency of electrical transmission of power for the Columbia Cotton Mills, if not greater than, is certainly equal to the efficiency obtained by using belt or rope transmission in the average cotton mill.

The new fine goods mill that is being put up by the Pelzer Manufacturing Company of Pelzer, S. C., furnishes another example of the

practical application of electric power. Mills Nos. 1 and 2 are driven by turbines, and No. 3 by a steam engine. These mills are on the Saluda river in Anderson Co., S. C., and are connected with the Columbia and Greenville Rail Road by a spur about ½ mile long. This company, desiring to add another mill, decided to make use of a waterfall about 2½ miles lower down the river that has a capacity of about 5000 h. p. It would have required heavy expense for excavations and foundations to have built the mill near enough to use either belt or rope transmission; so, after taking everything into consideration, it was decided to locate the mill near the other mills, where a good site could be found convenient to the spur from the railroad, and transmit the power necessary to operate the mill from the water power about 2⅝ miles distant. The dam which is now being built will have a capacity of 5000 h. p., and the new mill will be 505 ft. long, 128 ft. wide, and 4 stories high. Its capacity will be 50,000 spindles and 1700 looms, and only fine goods will be manufactured.

At the power station there will be three 1000-h. p. generators, connected direct to three horizontal turbines, running at a speed of 166 revolutions per minute. The engine that is running mill No. 3 will be replaced by a 400-h. p. synchronous motor. The new mill will require for its operation two 50-h. p. motors, four 75-h. p. motors, fourteen 110-h. p. motors, and one 20 h. p. motor. Twelve hundred 16-c. p. incandescent lamps will be used for lighting the new mill, requiring 120 h. p. The guaranteed efficiency of this plant from turbine shaft to motor shaft is 80 per cent. The largest belt in use in the mill will be 8 in. wide, and the largest pulley 30 in. in diameter. Every room is independent, and any one room may be operated without necessitating the running of long lines of shafting. The generators and motors are practically the same as those in the Columbia mills.

The advantages gained by using electrical transmission for this mill are as follows: (1) the location of the new mill at a good site, thereby saving heavy expense for excavations and foundations; (2) the mill will be near the spur from the railroad, thus saving the building and maintaining of a railroad about 3 miles long and the operation of the same; (3) the proximity of the company's offices, and hence greater convenience to the officers of the mill; (4) the saving of the duplication of the mill village conveniences, such as churches, schools, stores, lyceum, halls, etc.; (5) the mills, being near together, will be better managed than they would be if separated; (6) the replacing of the steam engine operating Mill No. 3 by an electric motor, thus saving the company an annual consumption of over 3000 tons of coal, or very nearly $10,000.

In this plant there will be very little difference in efficiency in

consequence of the employment of electric transmission. Where the water power is abundant, as in this case, the question of a small difference in efficiency is not of much importance. The saving in the cost of building the mill where it is now located over what would have been the cost had it been built near enough to use belt or rope transmission, added to the saving of the cost of building a railroad 3 miles long and the saving of the cost of belts connecting different lines of shafting, very nearly equals the cost of the generators, motors, line, and lamps for lighting the mill, including the 400-h. p. motor for Mill No. 3.

The power transmitted by electricity for the operation of this mill is more economical than if it were generated by steam engines. Referring to a table showing the comparative cost of steam power developed in engines of different types, gotten up by Dr. Charles E. Emery of New York, we obtain the following data on compound low-speed condensing engines,—the kind that probably would have been used if steam power had been adopted. Friction loss of engine, 11 per cent.; pounds of coal per indicated horse-power per day of 11 hours (allowing for starting and stopping fires), 26. The coal assumed is a fair average, based on an evaporation of 8½ lbs. of water per pound of coal.

In order to have sufficient power to operate this mill, an allowance would have to be made for engine and shafting friction. Taking the friction loss of the engine from the table,—*viz.*, 11 per cent., —and assuming that the friction of one shafting (outside of the shafting to which the different machines are belted, thus putting the comparison on the same footing in both cases) increases this to 20 per cent., we would have to have an indicated horse power of 3000. The daily consumption of coal would then be 78,000 pounds, or 39 tons,—a yearly consumption (assuming 308 working days) of 12,012 tons. Assuming a price of $3.25 per ton delivered at the mill, this consumption would amount to $39,000. Now, if the interest on the cost of the dam, turbines, power station, generators, line, transformers, and motors, minus the cost of the steam plant, including chimneys, stacks, buildings, etc., exceeds this sum of $39,000, electrical transmission would evidently be out of the question. But, as a matter of fact, the interest on the cost of the complete turbine and electrical plant, including generators, motors, lines, etc., minus the cost of the steam plant, assuming 6 per cent. interest, would not amount to one-third of the cost of the coal consumption.

After considering every phase of the question, the conclusion must be drawn that the adoption of electrical transmission by this company was decidedly a step in the right direction.

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A Rev....Architectural Review. *s-q.* $5. Boston.
A S ...Age of Steel. *w.* $3. St. Louis.
A S I E .An. of Amer. Soc. of Irri. Eng. 1892-93.
A S M E.Am. Soc. of Mec. Eng. *m.* New York.
B .....The Builder. *w.* 26*s.* London.
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F'y .....Fairplay. *w.* 32*s.* 6*d.* London.
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G M.....The Geol. Mag. *m.* 18*s.* London.
G R.....Good Roads. *m.* $1. New York.
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H & V...Heating and Ventilation. *m.* $1. N. Y.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
I Eng ...Indian Engineer. *w.* 20 Rs. Calcutta.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B .....Carpenter and Builder. *w.* 8*s.* 8*d.* London.
I C T .....Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv.....Invention. *w.* 11*s.* London.
Ir Age..Iron Age. *w.* $4.50. New York.
I R W...India Rubber World. *m.* $3. New York.
Iry .....Ironmongery. *w.* 3*s.* London.
I S F.....Industry. *m.* $2. San Francisco.
I T R ...Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S. Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E . Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I .....Jour. Franklin Institute. *m* $5. Phila.
J G L .....Journal of Gas Lighting. *w.* London.
J M W A. Jour. of United Metal Workers of America. *w.* $1. N. Y.
J N E W. Jour. N. E. Waterw. Ass. *q.* $2. New London.
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P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A ....Railway Age. *w.* $4. Chicago.
R C J ...Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7*s.* London.
R R.....Railway Review. *w.* $4. Chicago.
R W.....Railway World. *m.* 5*s.* London.
Ry T. . The Railway Times. £1. 5*s.* London.
S . .....Stone. *m.* $2. Chicago.
S A .....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc.... ...Science. *w.* $5. Lancaster, Pa.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
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S E.....Stationary Engineer. *m.* $1. Chicago.
S Ec ....Social Economist. *m.* $1.50. N. Y.
Sea.....Seaboard. *w.* $2. New York.
S In.....Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L.....Steamship. *m* Leith, Scotland.
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S M Q....School of Mines Quarterly. $2. N. Y.
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S P.....Sanitary Plumber. *s-m.* $2. New York.
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S R J....Street Railway Journal. *m.* $4. New York.
S R R. .Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T ... .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E. Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E . Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q .....Technology Quarterly. $3. Boston.
Tr.... Transport. *w.* £1. 5*s.* London.
Tr A M E. Trans. Am. Ins. of Mining Eng. N. Y.
T W A...Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E.....Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

London Stables.

THE proper housing of horses has received much attention from the architect's standpoint, and, as a result, these useful animals are now provided with comfortable and, in many cases, what may be styled even luxurious quarters. The subject covers many lines of construction, from compact, neat, and ornamental stables for private owners of valuable stock to livery stables, hotel stables, and the great street-car stables. Probably the cities of the United States can furnish as choice specimens of stable architecture as the world can supply; nevertheless, it is not uninteresting to read what *The Illustrated Carpenter and Builder* (Jan. 11) has to say about London stables.

First, as to the number of horses belonging to the working class, not including private carriage and riding horses; there are eighty thousand horses "working for their living in the streets of London. Of these, twenty thousand are omnibus horses, ten thousand are car horses, fifteen thousand are cab horses, and twenty-seven thousand are employed in the carrying trade. A ruling consideration in the construction of stables for London horses is the great value of the land on which they have to be erected. This was not so much so in the past, however, when many places were suburbs which are now amongst the most important parts of London; and therefore we find that most of the old-fashioned stables—those, for instance, belonging to old-established firms of carriers or brewers—are built in a very straggling manner and cover a large area of ground. Not so the stables of recent erection, which, as a rule, have been built in the most compact form possible. Thus, in a new block built by the Great Western Railroad close to its terminus at Paddington, there are no less than four floors of stables, one above the other, the top floor being almost as high as the adjacent hotel, with a look-out down on the station roof. The headquarters of Messrs Carter, Patterson & Co., the well-known London carriers, are in three floors, one over the other, and the London Road Car Company's depot at Fulham, which accommodates seven hundred horses and is considered the finest in Britain, consists of stables in two stories built around a quadrangle. For the handling and management of a large stud of horses, stables built in such compact forms as these present some advantages over old-fashioned straggling buildings, as they can readily be divided into sections, and thus the work of each horse-keeper can be clearly defined. Moreover, for light and ventilation, animals placed on the upper floors of a London building will generally be better off than those whose habitations are on a level with the ground. When the housing of working horses on a large scale in the heart of London first became common, these considerations were little regarded, and horses were often, for the sake of economy, stabled in the basements of buildings used for other purposes. Thus a portion of the large stud employed by the North Western Railroad are housed beneath the railway station at Broad street. The newest stables built by the company, however, stand on their own ground, and are lofty, bright, and airy. The greatest objection to stables built on several floors is the labor entailed in taking in supplies of food and bedding, and in removing manure, &c. In most large buildings of this type, however, hydraulic machinery is provided for these purposes."

One of the finest examples of London stable buildings is said to be that recently erected by the Great Northern Railroad close to its station at Farringdon Street, in the heart of the city. It accommodates two hundred cart-horses. The two upper floors only of this building are devoted to stables, the basement having been utilized for a warehouse, while on the ground floor

the railroad carts load and unload as well as remain under shelter, the horses being housed overhead. This arrangement is a healthy reversal of the old-fashioned plan alluded to above. The stables are ranged around the outer walls of the building in the form of a quadrangle, the center of which consists of an open well-hole covered by a glass roof. This roof is raised above the inner walls of the building so that an opening is left all around, through which a constant current of air passes up the well-hole from the street entrance on the ground floor. Moreover, each stable has windows in its outer wall fitted on the hopper principle. Running round the well-hole on each floor is a balcony, which is approached by two inclined ways, one on each side of the building, from the floor below. At the top of each inclined road, on the balcony, a water-trough is placed, so that the animals can be watered easily, both on entering and leaving their stalls. From each balcony admission is gained to the stables on its floor. These are divided in each case into seven sections, each of which has an opening to the balcony protected by a sliding-door. This enables each section to be isolated from the others in case of necessity, and, as the door slides on runners, it is impossible for a horse to get foul of them when entering or leaving its stall. Each section contains stalls for from ten to fifteen horses as well as a loose box for sick or vicious animals. The stalls are 9 ft. by 6 in. long by 6 ft. broad, and the loose boxes average 10 ft. by 12 ft. The average ground area allowed per horse is 90 ft., and the cubic space varies from 1000 ft. to 1440 ft. These dimensions meet the requirements of the best authorities on the subject. The inside walls of the stables are faced with glazed bricks, which are excellent both for light and cleanliness. Standing divisions made of pitch-pine are provided between the stalls. Swinging divisions are, perhaps, better for ventilation and sanitary reasons; but large horses, such as here housed, are apt to injure themselves against these. Each division is capped with iron to prevent crib biting, and a kicking board of elm, 6 in. wide, which can be renewed when worn out, is fastened close to the ground against the hither end of each partition. The mangers are of salt-glazed earthenware, and are made in two pieces, so that, if one is broken, the other is still available, and can be retained while the broken one is replaced. Flush boarding is nailed from the manger to the floor of the stall, so as to remove the risk of a horse injuring itself by knocking against the inside of the manger when rising from a recumbent position. No hayricks are provided, as chopped food only is given.

Architecture in India.

INDIA, from any point of view, presents more that is interesting to students than most other parts of the Orient. Its languages and dialects, mostly derived from one of the oldest known languages; its literature, art, religions; its architecture, manners, customs,—each and all have a picturesque character, transcending anything to be found among other eastern peoples. Its ancient architecture presents features of interest perhaps beyond anything to be found even in Egypt, that land of structural wonders. Interesting as it is, it has had little influence upon architecture anywhere else; nor has the influence of western architecture much affected the character of architecture in India, except so far as the English nation has planted upon the soil some of the incongruities of western styles, which, however, have never been adopted in any of the native architecture. Thus Indian architecture remains distinct and exclusive.

This and other points relating to Indian architecture are made the subject of a recent paper read by N. N. Waskelar before the Illinois Chapter of the American Institute of Architects, at Chicago, and serially printed in *The Inland Architect*, beginning in January. He asks: "Is it then worth while to go into India's architecture, when it is so exclusive, tangled in such intricate meshes? I think it not only deserves a passing notice, but a careful study. Greece and Rome, gentlemen, are dead and gone. India is a living reality. Although there have been influxes, there

have not been refluxes. The result is that every art has its living representative, every science its illustration, and a majority of them not easily surpassed. The works of an immense portion of the human race who have shown themselves capable of artistic development must be studied; more so, when it is a living art and can only be seen in action in India."

The styles of Indian architecture are named as the Buddhist, the Jain, the Saracenic, the Mohammedan, the Pathan, the Hindoo Proper, and the Mogul; but in the paper a broad classification into the Buddhist, the Mohammedan, and the Hindoo, is adopted. Indian architecture "has been wonderfully developed since the twelfth or thirteenth centuries, during the Mohammedan period of India's history. It is not known to this day what was the composition of the ingredients used in building structures to make them so lasting. I know in ordinary towns structures are standing this day—for centuries, they say—with cracks from top to bottom, which don't give way. Stone not being used in remote ages, it is useless to look for any architectural remains till after the date of Gautama Buddha, 540 B. C., or rather of King Asoka, the disciple of Buddha, who reigned from 272 to 236 B. C., and who was the first to use stone in structures. Most remote of his relics now left are the Lats, or inscribed pillars, ornamented with bands and moldings crowned by a sort of capital. It has been surmised that these must have been approaches to Buddha's temples, now no longer found. Besides these, there are topes, which exist in numbers in India. These are either to note some notable occurrence, or to mark sacred spots, or to cover the relics of Buddha himself. Topes consist of a stilted hemispherical dome surmounting a circular structure, access to which is by steps with niches for the reception of sacred repositories. Central India is full of these, and the most famous of all is at Sanchi, about one hundred and twenty feet in diameter and sixty feet high. This was built by King Asoka. Of the various invasions which have overrun India, some have left traces in the architecture of India. Some semi-Greek forms are yet to be seen in the northern provinces,—undoubtedly the remnants of the invasion of Alexander the Great.

"Besides these, there are caves, temples, and monasteries hewn out of solid rock. The older monasteries cut in the rock are several stories in height, and it is probable that these cells must have been used by devout Buddhists for the purpose of meditation or habitation; but many of these—the Jain and the Brahminical temples—display rich ornamentation and very elaborate workmanship indeed. Intricate moldings and other fantastic embellishments abound in numbers. Columns of all shapes and sizes are found; brackets frequently used in lieu of capitals; and, where capitals are used, almost every variety of fantastic form is noticeable. Some say no fixed laws exist and govern these relics, but original works of great antiquity do exist which show plan of buildings, their heights and details; and these could not have been merely thought of."

Descriptions of special structures follow the general discussion, some of these structures being very remarkable, as notably the cave temples hewn out of solid rock, and profusely decorated with elaborate and artistic sculptures. Considerable space is devoted to the Mohammedan architecture, of which India affords numerous examples, often standing side by side with the Hindoo and Jain temples.

The McKaig Bill.

ALL the architectural publications printed in the United States are noticing, and are almost unanimously favoring, the bill relating to the reorganization of the government architect's office. The favor accorded to the provisions of this bill is entirely justified by the past work of the office, which loudly calls for thorough reorganization. Some of the work—we might even say a large part of it—has been such as to reflect anything but credit on the architectural skill of the country. The object of the proposed bill is to reduce the functions of the government architect's office to a routine of purely administrative duties, and to relegate the work of designing structures to a board of high character,

which will distribute the work among the most skillful architects in the country. A letter addressed to President Cleveland and signed by the members of the executive committee of the Architectural League of New York has been widely distributed to the press, with another soliciting co-operation in securing the passage of the bill. In the letter to the president it is set forth that "the McKaig Bill represents the result of the joint efforts of the profession, and of those legislators and experts who have been working to reorganize the present methods and to establish new and better methods. In their judgment, this measure will accomplish the desired results in a wise and conservative manner, and will meet the requirements as nearly as any bill of general character can do." The results achieved at the World's Fair in Chicago are cited as evidence of what the architectural genius of this country is capable of doing, as contrasted with the disgracefully mediocre work of most of our public buildings.

We are informed that the bill originated with a few prominent and representative architects of New York city, who had learned that Secretary Carlisle favored a reorganization of the supervising architect's office. It was introduced into the house by Mr. McKaig, and into the senate by Senator Brice. It was drafted by architect George B. Post in consultation with the other architects mentioned, and also with the treasury department. How far the name, "supervising architect," has been justified by the workings of the office appears from the following extract from the report of the house committee, recommending the passage of the bill:

"The supervising architect rarely sees one of these government buildings while in course of construction. Its construction is generally under the supervision of some local carpenter or builder, who never made any pretence to architectural knowledge or study; whose appointment was secured, not because of his skill, but because of the political influence he could marshal, and whose greatest solicitude is to prolong the tenure of his employment by delaying the completion of the work. A building which, if the property of a private citizen, would be constructed in months, when erected by the government requires years for its completion. Of a public building at Detroit, Mich., where the construction was authorized eleven years ago, and $1,300,000 appropriated by Congress years since, the foundation walls are not yet completed. Indeed, the abuses in the method above referred to have become so serious that the committee cannot conscientiously recommend public buildings at many places where the economical and convenient transaction of business would justify such buildings, could they be provided at a cost not greatly exceeding the necessary expenditure by a private owner for similar purposes."

The report concludes with the statement that the measure advocated is intended to make the supervising architect "what the title of his office indicates, the supervisor of architects; not the government's architect, but the supervisor of the architects of the government's works."

Medieval Domestic Architecture.

MR. BARR FERREE, in a paper read before the Archæological Institute in Philadelphia on December 29, and printed in *The American Architect* (Jan. 12), calls attention to the value of medieval architecture as a study for architects of the present day, this value having been strongly impressed upon his mind by opportunities afforded him during his stay in France last summer. From his observations in France and a comprehensive scrutiny of architectural literature with the object of noting to what extent the dwellings of times prior to the Renaissance find a place in books, he positively asserts that "as yet there has been no general survey of the whole field of domestic architecture from the earliest times down to the end of the last century."

Disclaiming "actual acquaintance with ancient domestic architecture outside of France," Mr. Ferree says that, when he visited France, he was quite unprepared for the enormous number of houses of all sorts that he met with in his wanderings. "Not all of these were of historical value.

though their general effect, when seen up narrow streets, or in small bits, was intensely picturesque; a good deal has been injured by restorations, by rebuildings, and by repairs, until sometimes only a window-frame or a huge column remained to tell or to suggest what the original structure was like. By far the larger part of these ancient buildings are unstudied and unknown. Even the photographic series of the Commission of Historical Monuments contain but a few of them. For example: the new catalogue of M. Robert, the official photographer to the Commission, which has just been published, contains but seven photographs of the old buildings of the town of Montferrand, and two of these are details of whole structures included in the other photographers. This town of Montferrand, which is not inaccessible at all, being reached in a few minutes by electric railway from Clermont, is full of old houses, scarcely any building of importance having been erected there since the sixteenth century."

Whereas "M. Robert offers but four photographs" from subjects in Sarlat, "one of the most picturesque and strange towns in France . . . he could have gathered forty easier than . . . to have picked out the four. . . . And I might take up fifty towns and make the same report on them: scarcely a village in France that does not contain some type of ancient house architecture of more or less interest. And while speaking of the subject of photographs, it may be well to mention that almost nothing is done by local photographers. In some localities where there are well-known curiosities that are visited by occasional tourists, small photographs can be had of scarce more value than the simplest souvenirs. Anything like adequate photographing by local photographers is quite unknown." Any desire for the revivification of ancient art is disclaimed by Mr. Ferree. His main object is to indicate the exceeding richness of the field. A general scheme for the systematic study, illustration, and description of the domestic architecture of France by its numerous archæological societies is outlined. The favorable conditions for this line of study in France, assumed to exist also in other European countries, are: "(1) An enormously rich field, which (2) has scarcely been worked; (3) many important individual monuments have been studied, especially those of the Renaissance period; (4) what work has been done has been diffuse and without system; (5) a necessity for extended systematic study." There is small hope of this work being done by American architectural students. It will be a task involving more or less drudgery. "Earnest as many of these young men are, they want something striking to show for their work; it is the beautiful and the picturesque they are in search of. I doubt if much can be expected from them, through the uninteresting nature of much of the material to be studied. It is, further, work that requires long-continued labor to bring adequate returns. A study of a single building is scarcely likely to have the value that the study of a group in the same vicinity would have. It is, therefore, hardly possible, as the archæological outlook now is, to hope for much in this department from any but the French themselves. Whether it is in good form to suggest to them that this work needs to be done; whether it is advisable to advocate the general study of European domestic buildings throughout the whole continent, —I must leave to others to determine. My present purpose will have been accomplished when I repeat that in this one subject is an archæological field, close at hand and ready of access, of most amazing richness."

Decorative Iron Work.

THE revival in ornamental iron work is a noticeable feature in recent architecture. The increasing demand for art work in iron is now annually giving employment to a large number of people, and a better rate of wages is paid for such work than for ordinary iron work. In the *Iron Trade* (Jan. 3) the subject is discussed, and the date of the revival is placed about ten years ago. Whether the impulse given to art in iron is the outgrowth of the increased use of iron and steel beams and columns

in buildings, as intimated, may, perhaps, be doubted. But it is unquestionably true "that the American artist-blacksmith has found not only a new but a much wider field for the exercise of his craft, and it may be truthfully said not only that he has achieved a success equal to that of the most notable of his ancestors, but that he outstrips him in the adjustment of relative parts and the exact and harmonious adaptability of his equally artistic conceptions to every given function. Nor has this frank concession to modern exigencies been in any degree detrimental to the esthetic element in his work, as in all the qualities constituting good design the modern is quite the peer of the medieval smith."

However, it may be admitted that the facility with which iron lends itself to decorative purposes in that struggle to make the most of space which characterizes the architecture of the large office-building has had much influence upon the recent development of the art. "The high office-building has not only afforded our smith the opportunity, but has presented a problem to be solved only through his instrumentality; the elevator equipment, the displacement of wood and marble by the more graceful, pliant, and space-economizing iron, are in point, while the grille, from having been almost exclusively used in the church and cathedral, is now being set up in secular temples to guard the money-bags of commerce and trade, as in its earlier use it had been at once the reliquary and ornament of the church. The massive and gloomy corridors of the public and commercial structures of twenty years ago have given place to light and airy passage-ways, and this is largely due to the substitution of ornamental iron for other material, as a study of any one of the more modern, up-to-date structures will show."

Another reason for the sudden increase in the use of iron, both for interior and exterior decoration, may be found in the invention of processes for protecting iron from atmospheric influences,—processes of which medieval artists in iron were ignorant. Among these the Bower-Barff process stands prominent. Ornamental brass-work is also sharing in the revival, which seems to indicate the increased use of iron in buildings is not alone the cause of the increased favor in which metal art work is now held.

Decorative Hints from Frost.

MR. LESLIE RAMSEY, in *The Plumber and Decorator*, calls attention to the fact that the rich variety of organic forms, affording so many suggestions for design, has caused the likewise rich variety of inorganic forms to be comparatively ignored. Among the inorganic forms containing innumerable suggestions for designs are frost-forms on window-panes, and to these special attention is directed. He has also worked out some of these hints into designs for panels, wall-paper, etc., which indicate how fruitful these frost-painted panes may be, when treated by an artist in design. The frost-decoration of trees and shrubs is, much of it, strikingly beautiful, and Protean in variety. The great variety of beautiful forms presented by crystals of snow offers still further hints of decorative design; and, although all these forms are in themselves destitute of color, the refraction of light transmitted through them, or their illumination by artificial means, will supply color-effects of great beauty.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*28371. Recent Architecture in France. Ill. Barr Ferree (E Mag-March.) 3000 w.

†28389. The Steel Construction of Buildings. C. T. Purdy (B U W-Vol. I, No. 3.) 9500 w.

28429. Determination of Stresses in an Irregular Truss. George H. White (E R-Jan. 12.) 700 w.

28430. The Miller Stable, Buffalo, N. Y. Ill. (E R-Jan. 12.) 2500 w.

28432.—75 cts. Editorial Review of Paper by Thomas Hastings, on "High Buildings and

We supply copies of these articles. See introductory.

Good Architecture" (A Rev-Vol. III, No. 5.) 2400 w.

28433.—75 cts. Traveling Scholarships. C. H. Blackall (A Rev-Vol. III, No. 5.) 5600 w.

*28440. G. E. Street as a Draughtsman. Ill. B. (A L-Jan. 4.) 1500 w.

*28480. Decorative Hints from Frost. Ill. H. Leslie Ramsey (Pl D-Jan. 1.) 1000 w.

*28484. Decorating the Dining-Room (I C B-Jan. 4) 1500 w.

28486. The Study of Mediæval Domestic Architecture. Barr Ferree (A A-Jan. 12.) 2700 w.

*28493. Fountains Abbey. Ill. Anon. (B-Jan. 5.) 4500 w.

28555. About Chimneys. Fred. T. Hodgson (A & B-Jan. 19.) 4600 w.

28568. Thomas Jefferson, Architect. John Kevan Peebles, in the Alumni Bulletin (A A-Jan. 19.) 3800 w.

*28585. Window Glass. Anon. (I C B-Jan. 11.) 2500 w.

*28606. The Evolution of Ornament. (Extract.) George Coffey (A L-Jan. 11.) 4000 w.

*28611. Bedford Stone—Its History, Production and Popularity. Ill. (S-Jan.) 14500 w.

*28613. London Stables. Anon. (I C B-Jan. 11.) 1300 w.

*28633. Architectural Illustration. C. G. Harper (B A-Jan. 11.) 4800 w.

28699. Fireproofing Processes and Fireproofing Paints (E N-Jan. 24.) 1100 w.

28717. Specific Recommendations of the Tenement House Committee (A & B-Jan. 26.) 700 w.

*28760. Roofing Slate. Extracts from H. Brunner (I C B-Jan. 18.) 1300 w.

*28766. The Red Brick Order of Architecture (I C B-Jan. 18.) 1100 w.

*28774. The Study of Buildings To-day and in the Past. F. C. Penrose (B-Jan. 19.) 5500 w.

*28776. Hallam on the Progress of Domestic Architecture (A L-Jan. 18.) 5500 w.

*28804. Skeleton Construction. Fireproofing. Foundations. P. B. Wight (B B-Jan.) 1200 w.

*28807. Concrete in Cold Climates. Ross F. Tucker (B B-Jan.) 900 w.

28948. House Decoration. G. Jekyll (Sc A S-Feb 2) 4800 w.

†28994. Narrative Report on the Underpinning of the Calcutta High Court Buildings. Ill. Charles Warde (I E-Dec. 29.) 1500 w.

*29004. The Church of St. Mary, Harrow-on-the-Hill. Ill. Anon. (B-Jan. 26.) 4000 w.

*29005. Bricks and Brickwork. John Slater, with Discussion (B-Jan. 26.) 1700 w.

*29009. Architectural Conservatism. Anon. (B A-Jan. 25.) 600 w.

29111. Tests of Melan and Other Arches.—Made in New York by Mr. George Hill (R G-Feb. 8.) 400 w.

29124. Government Architecture — Letter from John M. Carrère (A & B-Feb. 9.) 1200 w.

29125. Sir C. L. Eastlake on the Decoration of Houses. From the Architect, London (A & B-Feb. 9.) 6000 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (A & B-Began May 6, 1893—39 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. Ill. William H. Burr (E R-Began Jan. 6, 1894—9 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. (S-Began Jan. 1894—11 parts to date—30 cts. each).

19218. Manhattan Life Insurance Building, New York City. Ill. (E R-Began Jan. 20, 1894—6 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (B B-Began Jan. 1894—13 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (A A-Began April 14—12 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April—9 parts to date—30 cts. each).

25177. Colonial Architecture in Western Massachusetts. Ill. George C. Gardner (A A-Began Sept. 15—3 parts to date—15 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (A & B-Began Oct. 13—4 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (I C B-Began Nov. 9—5 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. George Ashdown Audsley (A & B-Began Nov. 24—3 parts to date—15 cts. each).

27297. Strains in Compound Framed Structures. Ill. Francis Schumann (A A—Began Dec. 1—3 parts to date—15 cts. each).

27924. The Modern Theatre of the Continent. Edwin O. Sachs (B A-Began Dec. 14-Ended Jan. 25—5 parts—30 cts. each).

28018. Concretes, Cements and Mortars: Old and New. Fred. T. Hodgson (B B-Began Dec.—2 parts to date—30 cts. each).

28152. Reference Books in Architecture. Herbert Batsford (B A-Began Dec. 21—3 parts to date—30 cts. each).

28494. Bricks and Terra Cotta. Anon. (B-Began Jan. 5—4 parts to date—30 cts. each).

28556. The Treatment of Sculpture in Relation to Architecture. John Begg (A & B-Began Jan. 19—Ended Jan. 26—2 parts—15 cts. each).

28582. Architecture in India. N. N. Waslekar (I A-Began Jan.—1 part to date—45 cts).

28803. The Pen Drawing of Brick Architecture. Ill. Bertram G. Goodhue (B B-Began Jan.—1 part to date—30 cts).

28805. Fireproof Floor Arches. George Hill (B B-Began Jan.—1 part to date—30 cts).

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Draining the Zuyder Zee.

IN point of time and money required for its accomplishment, the proposed drainage of the Zuyder Zee is the grandest engineering scheme now contemplated. A work which it will take 33 years to execute, and which will cost more than $127,000,000, is not to be thought of lightly, even in this age of great engineering achievements. This scheme, discussed at length in *Engineering* (London, Jan. 18), has been proposed to the Dutch government by the Royal Commission appointed to consider the best method of draining and utilizing a large part of the submerged area—once a part of the main land—now covered by these waters. Though land reclamation has figured largely in Dutch engineering, the present scheme is very far beyond anything yet attempted by that enterprising nation, if not in the history of the world. There is no question, from an engineering standpoint, as to the practicability of the work; the only doubt seems to have been whether it would be wise financial policy for the Dutch government to incur the enormous expense involved in the completion of the project. However, it seems likely that this question will be decided in favor of the undertaking, and the next generation of Dutchmen will probably see much of this submerged area wrested from the dominion of the sea. The plan comprehends the reclamation of no less than 750 square miles, which can be used for agricultural and other purposes. From the above estimated cost it may be computed that, in order to reimburse the expense of the work to the government, the reclaimed land would need to be sold at about $250 an acre, assuming that interest has been taken into account in making up the estimate. But the chances are great that the estimated cost may be exceeded before the work is completed; and, if the actual value of the land were the only incentive to the carrying out of the scheme, it would probably not have met with the favor that the Royal Commission has accorded to it. But "on the broader considerations of national progress—in the expansion of territory, in the increase of trade and agriculture, and in the giving to thousands of people the opportunities of profitable employment—the scheme, vast and costly though it be, is one that will certainly recommend itself to patriotic Hollanders, and insure for them, should they carry it out, the gratitude of future generations. . . . From an engineering point of view the most interesting part of the scheme is the construction of the great northern embankment, which is to shut out the ocean and change the region in question from a branch of the sea into an inland and eventually fresh-water lake. After a good deal of consideration, in the course of which six different lines of direction were examined, the commission decided to recommend that this embankment should begin on the north-west coast opposite the island of Wieringen, and in the first place join that island to the mainland, thus closing the neck of the sea known as the Amstel-diep. Commencing again on the western point of Wieringen, the embankment would stretch nearly 25 miles right across the Zuyder Zee to the coast of Friesland, where it would join the land again at Piaam. This embankment is not only to shut out the sea, but is to form a public highway between North Holland and Friesland, and is to afford space also for a railway connecting two portions of the Netherlands between which, save for a very wide detour, communication can now be carried on by water only. In order to fix the height of this embankment, the Royal Commission had first to consider what possible sea levels must be provided against, judging from past experience The greatest height known to have been attained by the sea waves along the coast of the Zuyder Zee was in December, 1883, when, during an extremely severe storm, the sea rose near the Noorderkijk of

Drechterland, at Andijk, to a height of 2.30 meters above the sea level at Amsterdam, while the waves ran up to the summit of the embankment there, a height of 5 meters, and washed away the gravel-road. The average height of the new inclosing embankment has, therefore, been fixed at 5.40 meters,—that is to say, it will commence at 5.20 meters on the western side, and rise gradually to 5.60 meters at the eastern side. It is thus believed that the summit of the embankment will be safe even during the severest storms that are likely to occur. The island of Wieringen will be protected by an embankment of similar height."

The further details of the work occupy some six columns of *Engineering*. Only one of these, the reclamation of the land, after the great embankment is complete, by the drainage of the polders, of which there will be four, can be noticed. "Along the outer line of the space to be reclaimed, in each instance, a dyke will be constructed, powerful enough to keep out the force of water represented by the Yssel Meer, such dyke being much about the same in form and character as the northern embankment, though of course it will not require to be so strong as the one that is to keep the ocean itself in check. Each dyke will be broad enough to have its roadway and pumping stations, and, as soon as it is ready, these stations will be built, and the pumping engines will be set to work to pump the water out of the inclosed space into the Yssel Meer. As already mentioned, a great deal of the Zuyder Zee consists of shallow sandbanks, and it will not be long, when the pumps are in full working order, before these banks appear above the surface of the water. As soon as a certain space is cleared, it will be surrounded by a small embankment, and form the first section, on which operations with a view to preparing it for agricultural purposes may be commenced at once, while the pumps are operating on the lower parts of the large inclosed space that are still under water. So the work will go on until the whole of the space inclosed by the main dam of the polder has been laid dry, and the different sections of that polder, each with a separate embankment of its own, and varying in shape according to depth, have been completed. The polders will, of course, be fully protected from any inflow of water from the Yssel Meer, while the drainage of an expanse of land which will lie considerably deeper than the surface of the lake shut out from it will be secured by a network of canals of various dimensions and at different levels, the water being pumped from the lower into the upper levels, until it can run into the Yssel Meer, and thence, through the sluices, into the sea." Mr. C. Lely, for a time chairman of the Royal Commission, and who has also filled the post of minister of the war department for the Dutch government, is credited with being the projector of all the essential features of this great enterprise.

Famous Bridges.

A RAPID review of the famous bridges of the world, past and present, is given by Mr. Robert Jamison in the *Chautauquan* for February. The first bridges were not bridges, in our now accepted meaning of the term, but piles of stones and logs, thrown into streams, over which people could pass by stepping from one to the other. These piles of rubbish were, however, the parents of the more modern masonry piers for bridges; and, when it was discovered that by laying poles or timbers from one pile to another the piers could be placed at a wider distance from each other and a continuous roadway constructed, the bridge as it has been known for ages had its birth. The next step was to connect the piers by arches, and for centuries far the greater number of bridges were thus constructed. The engineering genius of the present century has produced a variety of forms, among which are truss bridges, tubular bridges, suspension bridges, and cantilever bridges.

"Bridges of wood are mentioned as early as 1200 B. C. Homer refers to them also, and the first bridge built in Rome appears to have been built about 600 B. C. These early bridges were probably simple pile bridges, such as may be seen over many small streams in this country. The

oldest bridge in existence in England is believed to be a bridge on Dartmoor. It consists of simple masonry piers with flat sides of stone for beams on top, and is thought to be about 2000 years old. Arched bridges of solid masonry were built by the Romans all over Europe. One of these, built at Alcantara, Spain, about A. D. 104, still shows by its ruins that it must have been in its day a very famous bridge. It was 670 feet long and 210 feet high, and consisted of a series of six arches of different sizes. The many great aqueducts built by the Romans were true bridges, and in their very ruins testify to the skill and courage of their great builders. The contest between the bridge and the boat is probably very old, for the Romans learned the art of making drawbridges (which were simple lifts) to allow boats to pass the bridge. The Chinese were also great bridge-builders since the very earliest times. The records of their great bridges are not very definite; yet it is clear they knew how to make masonry arches of great height and span.

"After the Roman bridges, there came many others of both wood and stone. A masonry arch bridge, founded by St. Benedret at Avignon in A. D. 1177, consisted of eighteen arches, the bridge being bowed upstream to resist the current. It was many years in building, and, like nearly every old bridge in Europe, was destroyed in some war. Old London Bridge was regarded as one of the wonders of the world. It had nineteen stone arches and was covered with buildings, except at the middle where the draw was placed. It was commenced A. D. 1176, and was not completed till 33 years after. The longest single span arch is said to have stood at Tresso. The bridge had a span of 251 feet and was 87 feet high. It was built in 1380, and was a famous bridge in its day. Nothing now remains except a small portion of the arch."

The "Bridge of Sighs" in Venice, which spans a narrow passage-way between a courthouse and a prison, is considered the most famous bridge in Europe; but it is for historical reasons rather than its engineering features that this bridge has become so widely known. Other bridges are famous for battles fought at or near them. The greatest impulse the art of bridge-building ever received was from the enormous demand for bridges and viaducts created by railroads. High and strong bridges were required, and, as in the United States, in the earlier stages of railroad building, it was necessary to use wood for bridge structures, the country became famous for its wooden trestle bridges, which were the forerunners of the steel structures now supplanting wood and masonry bridges on railways.

"In looking over the gigantic structures erected within the past 20 years, it is difficult to say which is the most famous. Britannia Bridge, in its day, was world-famous. To-day it seems insignificant and almost foolish in point of cost and weight. Why make a huge iron box, when a spider-web structure of steel would carry the same load at far less cost? A bridge may be famous for its unusual construction, like the great Pontoon Bridge over the Húglí at Calcutta. It is 1530 feet long, and is supported on 28 iron boats coupled together in pairs, the roadway being carried on timbers erected on the decks of the pontoons. The bridge was erected in 1873, and is justly regarded as the most important floating bridge in the world. Another may be famous for its great length and immense traffic, the Elevated Railroad in New York (which is a true bridge) being an example. Another may be famous for its bold and rapid erection, as the celebrated Kinzua viaduct on the New York, Lake Erie, and Western Railroad. This bridge is 2052 feet long and 301 feet high, and is supported by 20 open-work towers of iron. The 1750 tons of iron posts, struts, and braces were distributed over the steep rough valley, erected by means of steam derricks and a force of 125 men, and the structure completed between May 5 and August 29. The entire structure, including the laying of the foundations, was built in 8½ months, and the cost was $275,000. Comparing this with the celebrated railroad masonry viaduct over the Göltzsch Valley on the Saxon Bavarian State Railroad, we find that the German

bridge, which is 1900 feet long and 263 feet high, cost $1,680,000 and over 5 years of labor. There can be no question as to which is the cheaper and better in a commercial sense. The Göltzsch bridge would be by many regarded as the most beautiful and the most permanent; yet it must be observed that the airy, thread-like structure of the Kinzua Valley has a strange, fascinating beauty of its own, and it may outlast the big stone viaduct, for, in an earthquake, the stone bridge would come down first. Regarded as a simple bridge, it is plain that the stone bridge will not be the type of the future bridge; cost settles that. The railroad bridge is for the people, and the people must be transported cheaply."

The most famous suspension bridges are the Niagara and Brooklyn bridges, and the latter is the most famous bridge of its class in the world. The Tower Bridge, in London, is one of the most interesting of recently-erected bridges. It is a combination of a suspension bridge and a drawbridge. Its cost was $5,000,000.

A Famous Bridge-Builder.

THE recently-elected president of the American Society of Civil Engineers, Mr. George S. Morison, of whom a biographical sketch with portrait is printed in *The Railroad Gazette* (Jan. 18), has probably had as extensive an experience in the construction of bridges as any other engineer, past or present, notwithstanding he has turned his attention to a wide field outside of bridge-building. "He built, as chief engineer, nine bridges across the Missouri in the interval from 1887 to 1893. The last of these were the bridges at Bellefontaine, Mo., and Leavenworth, Kan., both of which were completed in 1893. He built three bridges across the upper Mississippi in the four years 1890–1893, inclusive, the latest of these being the Alton bridge, and one of them, the Burlington bridge, having been rebuilt. He was also consulting engineer of the St. Louis Merchants' bridge. The greatest of his bridges, however, is that across the lower Mississippi at Memphis, completed in 1892. This has a main span 790.42 ft. long, and two river spans of 621 ft. each. The total length of the bridge proper is 2,597 ft., and, including the viaduct approaches, 4988 ft. There are but two bridges in the world with longer trussed spans,—the Forth bridge, with two spans each 1710 ft. long, and the Landsdowne bridge (Sukkur), with one span of 820 ft. Only one other bridge has reached such a great depth by pneumatic caissons,—the Eads bridge at St. Louis. The table below gives the depths reached and the greatest immersion while work in the caissons was in progress:

	Below l. w.	Below h. w.	Immersion.
Memphis....	96.2 ft.	130.8	108.
Eads.....	94.	135.5	109.7

"In this work singular difficulties were met by highly original methods.

"Mr. Morison also built a bridge across the Ohio river at Cairo; . . . . one across the Willamette at Portland, Ore.; one across the Snake river at Riparia, Wash.; and one across the St. John's river at Jacksonville, Fla. Besides these, he has built a good many smaller bridges and viaducts for various companies. The aggregate length of his large bridges is about five miles. Within the last year he served as one of the Board of Engineers appointed by President Cleveland to report on the project for bridging the Hudson river at New York.

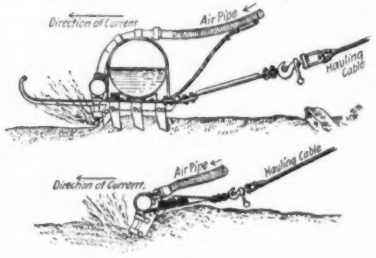
"The Missouri is one of the most troublesome of all the great rivers of the world. Its swift current, changing channel, and treacherous bottom unite to make it the dread of engineers. In the nine great bridges which Mr. Morison has built over that stream unexampled combinations of difficulties came up. In this work, as in all the other bridge work which has been specified above, on streams offering a great variety of physical conditions, Mr. Morison was the actual chief engineer, controlling everything to the last detail."

Dredging with Compressed Air.

A METHOD of dredging with compressed air is described in *Engineering News* (Jan. 17), with illustrations from *Le Génie Civil*, herewith reproduced. The principle was first used by a Mr. Wheeler, in 1893, for

dredging mud from the port of Tilbury. The apparatus illustrated is, however, from designs of Mr. Moorman, and for use in the lower channel of the Weser river.

Mr. Wheeler "based his original deductions upon the fact that in dredging there are two distinct operations,—the loosening of the material from its bed and its removal. In fine materials, like mud, or sedimentary matter, which can be carried in suspension by the current, this current is often depended upon to transport it after it is artificially stirred up. But the velocity of transportation is often feeble, depending upon that of prevailing currents; and the distance of transportation depends upon the height to which it is possible to lift the solid particles in the stirring process. With this in view Mr. Wheeler made a series of experiments at Tilbury, founded



Compressed Air Dredging Apparatus.

upon the theory that the resistance of gravity, for any particle transported in a current of water, was proportional to the velocity of this current; and that in a vacuum, with an initial horizontal velocity given to a particle, the distance to which the particle would be carried was proportional to the square root of the height at starting, as the path would be parabolic. It was then evident that in attempting to remove mud by stirring, when there was little natural current, it was essential to lift the mud particles artificially as high as possible. At Tilbury a water jet was used for this purpose; but on the Weser compressed air was applied to this end, as here shown."

The apparatus, as shown in the engraving, is remarkably simple. Its elements are "a plow and an air conduit. This plow, for mud of very little consistency, was built of light iron, and was provided with a cylindrical float which prevented it from sinking into the mud beyond a certain depth. It was equipped with a series of plowshares and drawn by a cable worked either from the bank or drawn from a boat. While it is moving, air is forced into a pipe fixed upon the rear of the carriage and provided with several vertical nozzles. As this air escapes from the nozzles, it agitates the water up to the surface, even in depths of from 23 to 26 ft., and gives an impulse to the water particles that is felt for 'several kilometers' of distance in a very feeble current.

"When the bottom is of stiffer mud, the number of shares on the plow is reduced, and the float is replaced by a load of castings or a block of stone. This apparatus is claimed to possess important advantages over the floating dredge, especially when employed at sea, because it can be advantageously used in stormy weather and rough water, when the ordinary dredge would be entirely unavailable. As to the choice to be made between water-jets and compressed air, the inventor prefers the latter. Not only are the air-compressors and conduits required less cumbersome than if water were used for the same work, bnt the air leaving the nozzles, beside acting upon the loosened mud on the bottom, has a tendency to lift the muddy particles towards the surface, and thus increase the distance of transport. The effect of the water-jet is almost wholly expended upon the bottom material, and comparatively little power is left to aid in transport." The results of this method will be awaited with interest.

The Chicago Canal and the St. Lawrence River.

MR. CHARLES BAILLARGÉ, C. E., of Quebec, discusses, in *The Canadian Architect and Builder*, the effect on the commerce of the St. Lawrence which will be produced by the Chicago drainage works now in progress of construction; and he enters into a calculation to show that this effect will be injurious. The canal will run 10,000 cubic ft. per second. "On the other hand, Niagara runs 18,000,000 cubic

ft. of water per minute from Erie and the upper lakes into Ontario and the St. Lawrence, or 300,000 cubic ft. per second." From these data it can be easily seen that the flow through the St. Lawrence will be diminished by one-thirtieth; and this is the basis for an assumption that the depth of the river will be decreased by the same fractional part, 'which, even on the channel of St. Peter, must tell against the present draft of ocean steamers."

But this is only a beginning, in the opinion of Mr. Baillargé. "Chicago, whose population is now but two millions, or close upon that, in the near future may and likely will swell to six millions in another half or quarter of a century, when the canal will have to be enlarged to take the then increased drainage from the city with its percentage of diluting waters from Lake Michigan, in a way to run fully three times the quantity at present legally permitted. And that it may not be inferred that this is a gratuitous supposition, I have to remind your readers that extension has already been provided for in effecting the specifications necessary for the right of way. The ultimate flow through the canal will then probably be 30,000 cubic ft. per second, instead of only 10,000, and diminish by one-tenth the Niagara outpouring, and also by one-tenth the depth of flow of the St. Lawrence,—though by less below Montreal, due to such tributaries as the Ottawa, the St. Maurice, the Richelieu, and other side-issues,—thus seriously affecting the present possible draft of vessels through Lake St. Peter, with a demand by our friends of Montreal and westward for a further dredging of the channel by some 3 ft., or 10 per cent., to make good the loss in flow, to say nothing of the fact that other portions of our maritime highway from the Great Lakes to the Ocean must suffer in a like manner by forcing us to go back to river craft of less capacity."

Strangely, while "western traders east of Chicago" begin to see this, "the Montreal, Quebec, and other chambers of commerce and boards of trade have not, as yet, in any way alluded to the fact in any of their transactions." The question is raised whether one nation can legally "rob another of its God-given resources any more than" an individual can impound and cause to deviate the waters of a stream or any notable portion thereof, without having, as bound by law, to turn them back into the same natural bed or channel for the use of his next neighbors on a lower level.

A danger is also pointed out as likely to come in on the Huron and St. Charles above the dam, on account of increase of water, whereby lands that can now be cultivated may be submerged. Any increase of water in the Mississippi is also regarded as an increased menace to the levees, which are even now tried almost to the limit of their resistance during times of flood.

Cost of Macadam.

INTERESTING particulars of the cost of maintaining macadam roads in Berlin are given in *Paving and Municipal Engineering* for February. In the United States the use of macadam roadways in cities has not been so extensive as abroad, although for suburban roads and much-traveled roads in populous districts they have been considerably in vogue. The construction of such roads has, therefore, been placed largely in charge of civil engineers not directly connected with municipal departments. Berlin, on the contrary, has most of its principal streets paved with macadam, and the average cost of maintenance of these roads will be generally interesting to civil engineers, whether engaged in municipal work or otherwise. No less than 1,280,796 square yards of macadam have been laid in the streets of Berlin. Twelve of these streets are specifically selected, and the average cost of maintenance for each entire street is given. The lowest average annual cost of maintaining these roads, per square yard, is $0.112, at which figure two only of the streets in the list were maintained. The highest average cost (only reached on one street) was $0.365. The average for all the streets in the list, computed from the respective averages, is $0.21533. The first cost of telford or macadam roads is about the same as in other European cities. The cost of

maintenance of macadam is estimated as two or three times that of asphalt roads. This is accounted for by the better character of the repair work done in Berlin which really amounts to a thorough renovation, an example that might well be imitated in American cities, which, however it will be hopeless to look for until all public engineering work can be divorced from politics.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

28542. Recent Small Bridges on the Baltimore and Ohio. Ill. (R G-Jan. 18.) 2000 w.

28592. The Gaspee Street Bridge, Providence, R. I. Ill. (E R-Jan. 19.) 1300 w.

*28605. Old London Bridge (Extract.) Charles Welsh (A L-Jan. 11.) 3300 w.

*28641. Famous Bridges of the World. Robert Jamison (Ch-Feb.) 4000 w.

28696. A Novel Swinging Foot Bridge. Ill. (E N-Jan. 24.) 600 w.

29084. A Bridge Works' Rules for Drafting Room Work. Charles H. Wright (E N-Feb. 7.) 4000 w.

29094. Electrically Operated Rolling Lift Bridge, Van Buren street, Chicago. Ill. (W E-Feb. 9.) 2500 w.

29133. The Theory of the Suspension Bridge. R. W. R. (E M J-Feb. 9.) 2000 w.

Canals, Rivers and Harbors.

*28375. Causes of Floods in Western Rivers. Ill. Charles B. Going (E Mag-March.) 3000 w.

*28462. Harbors and Waterways. Editorial Review of 1894 (Eng L-Jan. 4.) 3200 w.

28587. The Chicago Drainage Canal—Messrs. McArthur Brothers' Contract (R A-Jan. 18.) 3800 w.

*28646. Effect on the St. Lawrence of the Proposed Deviation of a Portion of Its Waters Toward the Gulf of Mexico, by the Chicago Canal Now in Process of Execution. Charles Baillairgé (Can A-Jan.) 1000 w.

†28658. The Rivers of the Punjab. Ill. E. A. Sibold (I E-Dec. 22.) 1500 w.

†28659. Improving the Navigability of a River by Training. H. Engels (I Eng-Dec. 22.) 1000 w.

28677. Erie Canal Improvement. Editorial (A M-Jan. 24.) 900 w.

*28730. The Suez and the Manchester Ship Canals. E. Leader Williams (C G-Jan. 18.) 5400 w.

*28749. The Nicaragua Canal Scheme (Tr-Jan. 18.) 1300 w.

28889. The Brazos River Harbor Works (E N-Jan. 31.) 900 w.

28895. Dredging With Compressed Air. Apparatus of Mr. Moormann. Ill. (E N-Jan. 17.) 700 w.

29078. Improvements in New York Harbor during 1894 (Sc A-Feb. 9.) 600 w.

*29083. The Inland Waterways of Germany (Tr-Jan. 25.) 2500 w.

29129. An Exclusive Stadia Method of Making River Surveys. (Abstract.) J. L. Van Ornum (E R-Feb. 9.) 1400 w.

Hydraulics.

28893. Movement of Water Over a Dam with Wide Horizontal Top. Ill. Edward N Pike, with Reply from J. P. Frizell (E N-Jan. 31.) 1300 w.

28894. On the Flow of Water Over Weirs with Rounded Crests. Ill. N. Werenskiold, with Reply from J. P. Frizell (E N-Jan. 31.) 2500 w.

Miscellany.

*28459. Civil Engineering. Editorial Review of 1894 (Eng L-Jan. 4.) 5400 w.

28695. The Puget Sound Dry-Dock, Port Orchard, Washington. Ill. (E N-Jan. 24.) 1200 w.

*28721. The Draining of the Zuyder Zee. Ill. (E-Jan. 18.) 3000 w.

†28789. Specifications for Portland Cements and Cement Mortars. Frederick H. Lewis (P E C P-Jan.) 13000 w.

28882. The Sandy Lake Dam and Weirs. Ill. (E R-Feb. 2.) 2300 w.

*28971. Brandt's Rock Drills. Ill. (Eng L-Jan. 25.) 1100 w.

29003. George S. Morison, President of the American Society of Civil Engineers (R G-Jan. 18.) 800 w.

*29042. Civil Engineering in 1894 (E Rev-Jan. 21.) 2500 w.

*29065. Vibrations of Dams. E. R. Beardsley (Am M-Feb.) 600 w.

29085. American Types of Movable Dams and their Development. Ill. Hiram M. Chittenden (E N-Feb. 7.) 3500 w.

Serials.

26914. Waterways versus Railways (R A-Began Nov. 16—6 parts to date—15 cts. each).

28458. The Simplon Tunnel. Ill. (Eng L-Began Jan. 4—4 parts to date—30 cts. each).

28495. The Blackwall Tunnel. Ill. Anon. (E-Began Jan. 4—1 part to date—30 cts).

28498. Thames Bridges. Ill. Anon. (E-Began Jan. 4—2 parts to date—30 cts. each).

28615. The Nebraska City Bridge. Ill. (E Began Jan. 11—Ended Jan. 25—2 parts—30 cts. each).

28662. Practical Bridge and Girder Construction. Anon. (M W-Began Jan. 18—1 part to date—30 cts).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Explosions of Kitchen Boilers.

IT has been claimed that by letting cold water flow in upon a boiler surface heated to redness, steam may be generated so rapidly as to burst the boiler. So far as this belief applies to kitchen boilers, the question was brought before the Manchester (Eng.) Steam-User's Association in 1867, and a description of experiments (well-nigh conclusive as against this view) was presented to that body and republished in *Engineering* and other English papers. Further experiments were made from time to time with a view to a final settlement of the question, and it now appears that the holding capacity of a boiler would have to be very small in proportion to the heated surface in order that pressure enough to burst it could be thus generated.

Experiments with a Lancashire boiler showed that with a boiler of that type the maximum pressure attainable by letting water flow on and over the tops of its red-hot flues was 27 lbs. per square inch. Here the cubic capacity was large as compared with the heated surface. The class of boilers known as "kitchen boilers" in England offered perhaps the extremest case of extent of surface that could be heated to redness as compared with cubic capacity, and it was justly thought by Mr. R. D. Munro, the chief engineer of the Scottish Boiler Insurance and Engine Inspection Company, Limited, that experiments with this type of boiler, if carefully performed, ought to settle the question practically and finally. The results of these experiments have been printed in a small volume, reviewed in *Engineering* (Jan. 4) under the title "Domestic Boiler Explosions." The experiments of Mr. Munro fully confirm the view that it is impossible to make a boiler explode by raising it to a red heat and turning cold water into it. "It may be cracked, or a side may open, but no explosion in the proper sense of the term takes place, a very small aperture being sufficient to pass all the steam generated."

"For the purpose of these experiments, a wrought-iron cylindrical shell, about 20 ft. long and 6 ft. diameter, was prepared and erected with its axis vertical. The boiler to be tested was placed inside this, so as to prevent damage being done if an explosion did occur. A furnace was fitted inside this shell, and over it was placed the boiler to be tested. The boilers experimented upon were taken from the general stock of the different makers, and were fair samples of the ordinary domestic boiler. As a preliminary, a series of experiments were made to determine the size of safety-valve necessary to prevent a rise of pressure above that corresponding to the load on the valve. With a so-called 'boot' boiler, having a capacity of 14 gallons and weighing over 160 lbs., it was found that a dead-weight safety-valve, ½ inch in diameter, was capable of passing all the steam which it was possible to generate. In making the experiments with the 'red-hot' boiler, it was found that a suitable safety-valve was again effective in preventing any serious rise of pressure, even when fully three-quarters of the whole surface of the boiler was raised to a red heat.

"In the first of these experiments the safety-valve was loaded to 10 lbs., and, on turning on the water, the pressure due to the steam generated by the hot surfaces rose to 12 lbs., after which it fell again to 6 lbs., which was due to the head of water in the supply-pipe. The steam produced apparently cleared the boiler of water, but in a few seconds a supply of water gained access to the boiler, sending the pressure up again to about 12 lbs., after which it fell below that due to the head. The 'geyser' action again recurred, a larger supply of water reaching the plates than in the previous case, with the result that a pressure of 16 lbs. was indicated on the maximum gages."

These experiments were varied in a great many ways. When the valve was loaded to 20 lbs., and "the boiler was made nearly white hot," and when water was forced in under a head of 12 lbs. per square inch, the pressure rose to a maximum of 44 lbs., and, steadily falling, was below the safety-valve load at the end of 22 seconds. Some distortion resulted, and a stay was started. The most decisive experiment of all, however, was the following:

"The safety-valves were locked fast, and the boiler heated as before. On turning on the water, the pressure gradually rose up to a maximum of 118 lbs. per square inch, when a part of the boiler gave way. There was, however, no explosion, a weld simply opening and letting the steam out quietly. The experiment was then repeated with a second boiler, which failed at 90 lbs. per square inch. As before, there was no explosion, there being no reserve of highly-heated water to keep up the pressure, as is necessary for a true explosion to occur. The boilers were not even shifted on their beds. Mr. Munro points out that, in many towns, a domestic boiler is quite as likely to run dry in summer as in winter, owing to the water supply being intermittent; but he has only found one case of a domestic boiler exploding in summer, and that was proved not to be due to shortness of water. In winter such explosions are frequent, and, in view of all the experiments which have now been made, it can hardly be doubted that they arise simply and solely from the plugging of the outlets, and that a suitable safety-valve forms a perfect guarantee against danger."

Greenhouse Heating.

IT is probable that comparatively few people are aware of the increasing extent to which dwellers in cities are supplied with table luxuries and floral adornments by cultivation in greenhouses. And as the power to gratify luxury among the wealthier classes increases, the conservatory becomes every year more in demand as an adjunct of the modern house, both in city and country. Success in greenhouse culture depends more upon judicious heating and ventilating than upon anything else except the maintenance of a proper hygrometric condition of the atmosphere and the necessary supply of water to the plants. In fact, if to the two requirements named we add the preparation of the soil used for potting and bedding, and the protection of plants from insect enemies, we have all the principal essentials for successful greenhouse culture.

In a paper read before the New York Florist's Club by Mr. Samuel Burns, member of the American Society of Heating and Ventilating Engineers, and printed in *The Iron Age*, the subject of heating greenhouses is treated historically, theoretically, and practically. The concluding portions of this paper contain good advice, and describe, in general terms, the merits of a system which, as its advantages become better known, seems destined to acquire a wide popularity. This advice, the soundness of which cannot be disputed, is that, in putting in hot water or steam apparatus for greenhouse heating, "there is no such phrase as '*good enough*' in the business; you must proceed carefully at all times with the pipe-tongs in one hand, the spirit-level in the other. Of course, an indifferent job of piping may work; were such not the case, I am afraid quite a number of our florists and private gardeners would have to call in the services of an expert. Where the piping is not put in properly, the circulation of the water or steam, if it circulates at all, will be sluggish, thus necessitating a greater force at the boiler, which means a greater expenditure of fuel than would be required under proper conditions. In all cases where a florist finds it necessary or advantageous to do his own piping, I should advise him to consult with the parties from whom he purchased the boiler, telling them plainly what he proposes doing, and ask them to furnish a plan of the work; this they will no doubt cheerfully do, for it is to their interest to have the work done well. With our modern boilers and systems of piping, the florist can regulate the temperature of various houses to suit the conditions required by different kinds of plants; the

improvements in this direction are shown by the magnificent specimens exhibited at our flower shows. The use of 2-inch pipes, in conjunction with a proper arrangement of valves, gives us an opportunity for subdividing the heat such as was not possible with pipes of larger size."

The new system, which Mr. Burns calls the "combination overhead and under-bench system," wherein the flow-pipes for hot water or steam are carried overhead, while the return-pipes are run back under the benches, presents the following advantages. (1) It can be adapted to the pressure system by placing a safety-valve on the expansion tank, or it can be used with an open tank, having no pressure but what is due to the column of water. (2) The heat is carried to the extreme end of the greenhouse in the shortest possible time, and, returning under the benches on either side, heats back to boiler from the extreme end, which can be kept at the same temperature as the end nearest the boiler. (3) It can be used on the up-hill or down-hill plan, to suit the grade of the greenhouse; this is very convenient when the house grades the wrong way. (4) An increase in the vertical height of the flow pipes is always followed by increased velocity, and therefore we get a quick circulation. (5) Last, but not least, should your greenhouse be situated in a place where you would strike water by digging down from 6 to 8 feet, or should you strike rock, this is the system that will help you out of your difficulty. I have carried out some work on this system where the base of the boiler was on a level with the heating pipes, and the water had to rise up to the return about 20 inches. We have a little boiler heating our office on this plan, where the main return-pipe travels about 50 feet along the floor, and about 18 inches below the return-pipe entering the boiler; after traveling 50 feet, this return-pipe drops under the floor about 10 inches, travels between two beams for about 17 feet, then rises up into the boiler; in both these cases the circulation is perfect. In greenhouse work I prefer to have a boiler pit at least 18 inches deep, so as to bring the return water back on a level. I have great faith in this system, for where I have used it the circulation has been very rapid, and the results more than I expected."

Popular Ideas of Ventilation.

THE crude notions popularly entertained upon the subject of ventilation are spoken of by a writer in *Heating and Ventilation* (Jan. 15) as standing in the way of progress in the art. These notions are not confined to ignorant people. Many fairly well educated persons remain who cannot understand that ventilation does not necessarily mean an open window, or a draft of wind, and who would fancy themselves ill-provided with pure air even in the best-ventilated rooms wherein these objectionable features were not certain evidence to eye and feeling that some pure outside air was entering. "The two ideas of wind and coolness form the whole of the public care or knowledge in regard to ventilation. There is also the incidental belief that foul air rises, and that there must be some means provided for letting it out. This idea takes concrete form in the little whirligigs seen in so many office-windows, and in the tendency towards opening windows at the top on 'general principles.'" The general belief and tradition is to make a hole somewhere in the upper part of the room, and then all foul odors, bad air, and other improper things in the atmosphere will quietly, and of their own accord and free will, let themselves out.

In these crude ideas we have practically all that the public knows or cares about ventilation. In the actual practice of the individual there is no intelligent appreciation of pure air, nor can most people tell whether the air they breathe is fit for respiration. Even people belonging to the educated classes do not use the evidence of their senses in regard to the quality of the air in their houses.

It is the duty of sanitary and ventilating engineers to educate the public up to a higher plane as regards ventilation; and, in order to do this, "there must be more general appreciation of the difference between pure air and foul air from their own characteristics rather than from circumstances which have nothing to do with

the case." This means, of course, that attention must be given to methods for testing the quality of air in and of itself, without reference to visible means of supplying it, or to its sensible effects upon the surface of the human body. "When this educational work has been accomplished, the field of the engineer who devotes himself exclusively to ventilation will be the widest of any belonging to the engineering profession."

Location of Gas-Meters in Buildings.

THIS subject came up in a recent convention of the National Association of Fire Engineers in Montreal, and a paper read by Mr. Samuel Abbott, Jr., superintendent of the Boston Protective Department, appears in *Fire and Water* (Jan. 19). As related to the spread and control of fire, the location of gas-meters in dwellings is of much greater moment than most people would suppose. Experience has demonstrated the fact "that the maximum degree of heat from a fire first occurs at the highest point in a room (except in the immediate location of a fire), and, such being the case, it would be necessary to so locate the meter as to insure a minimum degree of heat for a reasonable time, thereby allowing for the discovery of the fire and notification of the fire-extinguishing forces before the heat had arrived at such a temperature as to melt the lead connections to the supply and distributing pipes or the soldering used in the construction of the meter. Very few fires originate in the immediate vicinity of a window in a building. Those that do are discovered early, and are invariably easily extinguished."

It is therefore recommended that meters should be located at points in buildings where the heat will be longest in reaching them; and this is always a point as low as is practicable. In ordinary city dwellings meters are placed mostly in cellars; but in the large tenement-houses and flats each floor has its separate meter, and sometimes there are several on each floor.

The main supply-pipe leading into a building should be easily accessible through a window, and should be supplied with a stop-cock, either in the sidewalk, or where it can be reached through a cellar window, so that, in case of fire, the gas may be readily and promptly shut off from the entire building. These precepts are enforced by citations of examples of fires rendered disastrous by escaping gas, and that could not be readily controlled for want of the precautions named. Meters should be placed on or near the floors of the rooms containing them, and not, as is too often the case, on shelves near the ceiling.

Heating by Furnaces.

WHILE steam and hot-water heating are very desirable for such as can afford these luxuries, the majority of people are and will be obliged to resort to furnaces for warming their buildings, and furnace heating may be made very good by proper care in proportioning the supply of heat and in erecting the plants. In *Domestic Engineering*, for January, Mr. G. D. Hoffman contributes an article upon furnace heating which considers it from a practical standpoint, which ignores entirely "cheap, poorly constructed furnaces" and deals with only such well constructed furnaces as do not leak gas, smoke, or dust from their combustion chambers. In his opinion the supplying of an abundance of fresh air by a properly set furnace more than offsets the evil of the accompanying dust. However this may be, it is a fact that very effective ventilation may be accomplished by the use of furnaces for heating, as this is a system of indirect heating, bringing the air from outside into the interior of the building warmed to a suitable temperature for the comfort of the occupants. One of the principal objections to furnace heating has been the overheating of the air introduced into buildings, not that this has been, as some have supposed, the cause of vitiating the air through the consumption of organic matter contained in it. This objection has been tested sufficiently to prove its invalidity. The trouble with the overheated air is that it is unpleasant to those who are obliged to be near the registers that admit it. It is better to have a large amount of air moderately heated than a smaller amount

heated to a higher temperature. Mr. Hoffman points out that one of the hardest problems which presents itself for solution to the furnace man is to counteract the natural tendency for hot air to drift in the direction of the outside wide and thus cause the rooms on the windward side of the house to be cold, while the rooms on the other side are apt to be overheated. When furnaces are set in such manner that this action can take place (and it is very difficult to so set the furnaces that it can be obviated altogether) the building will be unequally heated and that side will be the colder which has the wind. In locations where the wind changes frequently, this renders uncertain the heating of the rooms, on any particular side of the building. The principle must be remembered that "air naturally flows in the direction of the least pressure and where there is the least resistance." The problem is to make the supply of cold air, acting through the cold air box, and pressing into the furnace chamber, gain sufficient force to overcome the resisting pressure of air in the rooms caused by the exterior winds.

Storm windows, ventilating flues, and independent controllable cold air ducts between rooms and furnace are the resources available to heating engineers for effecting this desirable result.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

27868. Improvements in Greenhouse Heating. Samuel Burns (Met W-Dec. 22.) 3800 w.

28414. Ventilation. George D. Hoffman (Met W-Jan. 12.) 2200 w.

28608. Proper Heating and Ventilating of School Buildings. Rufus R. Wade (H & V-Jan. 15.) 3500 w.

28610. The Popular Idea of Ventilation. Populi (H & V-Jan. 15.) 1500 w.

*28691. Furnace Heating. George D. Hoffmann (D E-Jan.) 1800 w.

28709. Determining Heating Power of Heating Systems. J. H. Kinealy (Met W-Jan. 26.) 1800 w.

28710. A Short Talk on the Construction of Hot Water Radiators. J. J. Wilson (Met W-Jan. 26.) 1300 w.

28711. The Heating and Ventilating Engineer—A Commercial View. Stewart A. Jellett (Met W-Jan. 26.) 1700 w.

28885. Steam-Heating Plant in the Hill Seminary. Ill. (E R-Feb. 2.) 1300 w.

28953. The Literature of Heating and Ventilating. Extracts. Hugh J. Barron (Met W-Feb. 2.) 1200 w.

28954. Heating and Ventilation of School Buildings. T. J. Waters (Met W-Feb. 2.) 3000 w.

*29055. Ventilators. Anon. (I C B-Jan. 25.) 1200 w.

29062. A Prison Heating and Ventilating Plant. Ill. Henry B. Prather (H & V-Feb. 1.) 2500 w.

Landscape Gardening.

28664. To Preserve the Palisades. Editorial (G & F-Jan. 23.) 1100 w.

Plumbing and Gas Fitting.

28557. Connecticut's Proposed Plumbing Law (Met W-Jan. 19.) 1800 w.

29127. Apprenticeship. (Abstract.) S. E. Dibble (Met W-Feb. 9.) 1200 w.

Miscellany.

†28408. The Economical and Efficient Disposal of the Household Garbage of New York. Thomas H. Manley and Douglas H. Stewart (San-Jan.) 2700 w.

Serials.

26907. Hot-Water Heating and Fitting. J. L. Saunders (H & V-Began Nov. 15—3 parts to date—15 cts. each).

27214. Combination Heating. Ill. J. W. Hughes (Met W-Began Dec. 1—3 parts to date—15 cts. each).

27783. Mechanical Heating and Ventilation. M. C. Huyett (I A-Began Aug.—6 parts to date—45 cts. each).

27848. The Names and Uses of Stops and Faucets. Ill. Calvin Fulton (S P-Began Dec. 15—3 parts to date—15 cts. each).

28431. Water Supply in the House of Mr. Cornelius Vanderbilt, New York City. Ill. (E R-Began Jan. 12—3 parts to date—15 cts. each).

28880. Heating Buildings — The Proper Rules to Use. Thomas Hawley (B J C-Began Feb. 2—1 part to date—15 cts).

29076. Installing Wood-Cased Bath Tubs. Ill. Grayson (S P-Began Feb. 1—1 part to date—15 cts).

29077. Practical Gas Fitting. Anon. (S P-Began Feb. 1—1 part to date—15 cts).

We supply copies of these articles. See introductory.

ELECTRICITY

A German Municipal Electric Station.

ONE of the finest examples of modern electrical engineering construction extant is that of Frankfort-on-the-Main, Germany, which is described in the *Electrical Engineer* (Jan. 9) by Dr. R. Haas. The plan of distribution adopted is that of the single-phase alternating current, but it appears that the determination to employ this was only arrived at after a very spirited controversy between the advocates of different systems, which occupied a number of years. The station, which commenced operations on October 12, 1894, has an ultimate capacity of 100,000 16-c. p. lamps. It is situated without the city on the bank of the river, at a point where coal and water are conveniently accessible. There are at present installed eight return tubular boilers with smoke-consuming furnaces. All the steam mains lead to a large drum, from which the engines draw their supply. Three engines are in position, and a fourth will soon be added. Each of these is a tandem compound, direct-coupled to a horizontal dynamo giving 500,000 watts at 3000 volts. The switchboard is located in a gallery, and is simple and convenient in design. Each dynamo has its separate complement of apparatus for control and regulation. The distributing system is entirely underground, and comprises high-tension feeders, high-tension mains, and low-tension mains. Six nodal points on the system of high-tension mains are fed by a corresponding number of feeders. Concentric asphalt-insulated cables are used, protected with an armor of iron ribbon. These are imbedded in sand in trenches about 3 ft. deep, and protected by a covering of brick, and, in some exposed places, of iron water-pipe. No connecting boxes are employed, the cables having been especially made in designated lengths, and thus a very high insulation is attained. The 3000-volt current is reduced to 110 volts by means of 90 transformers situated from 500 to 1000 ft. apart, which feed into a system of low-tension consumers' mains. The transformers are placed in pits under the sidewalks, which are lined with brick laid in cement. The transformer lies at the bottom submerged in oil; over this is a wooden floor covered with linoleum, and above this a space where the switches and safety devices are placed. The pit is closed with a ribbed cast-iron plate at the level of the sidewalk. Scale drawings of one of these pits are given, with details of the transformer-boxes. Moisture is carried off by a ventilating duct, the air circulation being effected by the heat given off by the transformer,—an arrangement which has proved highly satisfactory in practice. The distribution of current is excellent, the losses under maximum load being, in the feeders, 4 per cent.; in the high-tension mains, 1 per cent.; in the transformers, 4 per cent.; and in the low-tension mains, 1.2 per cent. The regulation is effected by the aid of pressure wires running back from the nodal points to the central station. The range of variation of pressure throughout the city seldom exceeds 1 per cent. in practice. The total cost—about $650,000—did not exceed the estimates, and the entire work was finished within six months from the time of its commencement.

The Edison Electric Company of Chicago.

THE *Electrical Engineer* (Jan. 23) devotes nearly twenty pages to an elaborate and well-illustrated article by T. C. Martin, descriptive of the works of the Chicago Edison Company. This company operates three distinct plants, but the main centre of interest, in a technical sense, is the great Harrison street station, which has been pronounced by capable critics by far the best example of advanced electric-light engineering to be found in the western hemisphere. The main engine and dynamo room of the station is well shown in a full-page photo-engraving of unusual excellence, and it certainly is a most impressive

sight. The room is 209 × 62 ft. on the floor, and 60 ft. in height, faced with cream-colored pressed brick and lighted from the roof. The equipment comprises ten large vertical triple-expansion engines of varying dimensions, driving direct-coupled multipolar generators, the present aggregate capacity being 6400 k. w. or approximately 10,000 h. p., with the necessary complement of pumps, heaters, condensers, filters, etc. The station is operated on the Edison low-tension three-wire system, each engine being a three-wire unit in itself, inasmuch as it drives a pair of generators connected through switches to the three bus-bars on the switchboard. The conducting cables are made of 259 strands of No. 13 copper wire. The boiler-room has capacity to accommodate fourteen boilers, of which seven are now in use. The fuel used is residuum oil, brought by railway in tank cars. The daily consumption of oil is about 9000 gallons. The switchboard is of Italian marble, set in steel channel-beams. The regulating portion is composed of sixteen panels, each 20 in. wide, making a total of 26 ft. 8 in. Each panel is devoted to one unit, and has all the necessary appliances in the way of switches and testing and indicating instruments. The original station at Adams street, in the business centre of the city, is now used solely as a distributing station, being connected with the Harrison street station by enormous trunk-line feeders. This trunk-line is 3,340 ft. in length, and is carried under the Chicago river by a special tunnel 60 ft. below the street surface. The dimensions of the positive and negative grouped conductors of this trunk line are 21,000,000 circular mils each, and that of the neutral 3,000,000. There must therefore be something like 225 tons of copper in this trunk-line alone. The business of the company appears to be extensive and profitable. The number of incandescent lamps connected has increased from 17,812 in 1889 to 161,927 in 1894, and the motor service from 234 h. p. in 1889 to 4,210 h. p. in 1894. It is worth noting that the motor service has already reached 40 per cent. of the lighting capacity, and must be in operation at least twice as many hours per day. Many of the large office-buildings in Chicago buy their current from the Edison company, instead of running isolated plants. Some of these buildings are very large consumers; the Monadnock building, for instance, has some eight thousand lights. Altogether, the details of this gigantic plant, which are very fully given in the article, cannot but repay the most careful study on the part of those interested in the modern practice of electric distribution on a large scale.

Electric Competition with Steam Railroads.

NO small amount of space is being devoted in these days, in technical and other journals, to various aspects of the competition which is springing up in various localities between the newly-established electric street railroads and the long-established local and suburban service of the steam railroads. The *Electrical Engineer* (Jan. 6) discusses the matter editorially, with particular reference to the measures which some of the steam roads are adopting to retain their business where it is threatened with "trolley competition." It is to be regretted that the editor of the *Electrical Engineer* can discover no better motive for the disposition of the various State railroad commissioners and State legislatures to seek to put a stop to the reckless and totally unnecessary multiplication of grade-crossing death-traps than a purely selfish desire to protect the steam roads from electric competition; but nevertheless the writer expresses the opinion that "even this obstacle put in the way of competing trolley lines will avail nothing." Admitting this to be the case, there would seem to be nothing more to be said. The only argument against the total and absolute prohibition of the crossing of steam by electric roads that is worth a moment's consideration is that the increased cost of the separated grades will prevent the building of some trolley roads which would otherwise be built. As for the steam railroads, it is probably safe to assume that they will be able to take care of themselves. No doubt the new electric lines have in some places diverted a large amount of traffic from their older rivals,

and caused the discontinuance, here and there, of a local train; but it is at least a question whether this loss has not been many times made up by new business brought to the steam lines from points not heretofore conveniently reached by existing modes of conveyance. As an example, who can doubt that the additional business brought to the Pennsylvania Railroad in such a city as Newark by the establishment of a vast system of converging trolley lines is not ten times as great as the amount diverted from it by the trolley lines which parallel it from Elizabeth to Jersey City? If the trolley lines can accommodate the travelling public better, or at lower fares than the steam railroads, they will get the business, and ought to have it. But if they cannot afford to do this without running at dangerous rates of speed along and across the public highways, and recklessly across grade-crossings, then the law should step in and check them. Millions of dollars have been spent by the principal railroad lines in this country within the past twenty years for the abolition of grade-crossings, and it is very much to be doubted if public opinion will permit this eminently necessary work to be stopped, and in some cases even undone, at the behest of the promoters of speculative electric street-railway enterprises.

How Incandescent Lamps Are Made.

ALTHOUGH fifteen years have passed since the first commercial introduction of the incandescent lamp, it is only within a few months that any adequate and intelligible account of the minute details of its manufacture has been published. Reference was made in this department a few months since to a somewhat elaborate article on this topic which appeared in journals devoted to the gas interest, and now we have, in the *Electrical Engineer* (Jan. 2), a detailed and well-illustrated account of the whole process of lamp-manufacture, as carried on in the extensive works of the General Electric Company at Harrison, N. J.,—the original establishment founded by Edison in 1882. Although the entire catalogue of material comprised in an incandescent lamp consists only of a glass bulb, a thread of carbon, two short pieces of copper wire and two of platinum wire, two shells of brass, and a little cement,—its only rivals in the realm of electricity in respect to simplicity being the magneto-telephone and the Morse sounder,—yet no less than forty-one different pairs of hands, exclusive of inspectors and carriers, are required to perform all the operations necessary to fit it for its destined work. Many of the processes are extremely delicate, and all are exceedingly interesting. It would take too much space to give even a bare outline of them here, so that those who are curious in the matter must be referred to the original article. It is a fact not generally known that the filaments of the best modern lamps are made of cellulose, as first proposed and practised by Weston, and that the carbon of fibrous structure so strongly insisted upon by the pioneers in the art of lamp-manufacture has become practically obsolete. The process of "flashing," or treating the filament in hydrocarbon medium while heated, originated by Sawyer and Man, has been adopted by this, as well as by all other successful manufactories. Some idea of the magnitude of the operations carried on at this factory may be gained from the statement that the present number of employees is 900, and that the aggregate output of lamps per day of 10 hours is no less than 28,000.

Modern Theories of Electricity.

IN the London *Electrician* (Jan. 18) Professor Oliver J. Lodge reviews at some length the article of Professor Rowland under the above title, which appeared in the January number of this magazine. Referring to Professor Rowland's explanation of the cause of terrestrial magnetism,—*viz.*, that the ether must be supposed to have such properties that the rotation in it of ordinary matter produces magnetism,—Professor Lodge says that this and other similar statements are full of "more than doubtful hypotheses"; that it has never been proved that magnetism is due to the rotation of something; that it is known that rotating electrification is a sufficient cause, but not necessarily ro-

tating ether; and that against the proposition that the spinning of matter on its axis magnetizes it may be adduced many specially-directed experiments, all of which have given a negative result. "The alternative view championed by Dr. Larmer, that magnetism may be due to flow, and electric current to spin," says Professor Lodge, "has evidently not yet impressed him (Professor Rowland) as possessing any force or validity. It may be assumed as probable that he has strong reasons for this orthodox Maxwellian belief, and it would be interesting to know them. He considers magnetism more simple and easy to comprehend than electro-statics, which again must be considered as a thoroughly Maxwellian position; and it is interesting to see how the great foreign philosophers of the world are all slowly coming to recognize the magnitude of this great teacher. Professor Rowland, indeed, has long recognized it, and it is hard to speak of members of the Anglo-Saxon race as foreigners; but their aloofness from insular prejudice and the bonds of mother country renders their adhesion to the English, instead of to one of the many forms of continental theory, of special interest."

The Power Plant at Niagara.

THE *Electrical Engineer* (Jan. 16) gives some account of the present condition of affairs at Niagara Falls, accompanied with photographic half-tone views of the power-house, exterior and interior, and the 5000-h. p. two-phase generator which has just been installed, together with a sectional drawing of the latter. A description of this machine is given, somewhat in detail, and an interesting letter from Professor George Forbes to the London *Times*, descriptive of the work which has been done, is republished in full. In summing up, Professor Forbes says:

"The period of planning the transmission scheme, of designing the greatest dynamo in the world, and of construction of the first plant now closes. The financial period commences with the new year. The earning of dividends and the ordering of duplicate machinery is the future work of the company. In conclusion, it is difficult for me to say who were the boldest,—the capitalists who embarked on the scheme before any plans were matured, or the manufacturers who moved their factories to this field before a single result had been achieved. The action of both was typically American, but their confidence was not misplaced. Their success is now assured."

Another article on the same subject by Frank C. Perkins, with a number of additional illustrations, and further details of the progress of installation, appears in the *Electrical World* (Feb. 9).

The Electric Conductivity of Water.

MR. J. W. RODGER contributes to *Nature* (Nov. 8) an interesting *résumé* of the investigations which have been prosecuted within the past few years for the purpose of determining the electrical conductivity of pure water. Observations of this character have been rendered exceptionally difficult by reason of the impossibility of freeing the water from the last traces of dissolved impurity. According to the latest determinations, one millimeter of water has at 0° almost the same resistance as 40,000,000 kilometers of copper wire of the same cross-section. It has been suspected that absolutely pure water might turn out to be a non-conductor. But Kolrausch and Heydwiller, by means of the hypotheses involved in the new theory of solutions, have shown that it must be a conductor, and they fix its probable conductivity at 18° at 0.0043 of that of mercury, which is taken at 10^{10}, the accepted figure prior to 1875.

Storage-Battery Manufacture.

THE storage battery has long been an important factor in the economical production and distribution of currents from central stations in all European countries, but for various reasons, some of which have heretofore been adverted to in this department, it has never met with much favor among central-station managers in this country. But indications are not wanting that in this respect matters will

soon assume an entirely different phase. The controlling patents and the most prominent business interests in this field in the United States have recently been united in a single organization, and the manufacture has been commenced in Philadelphia on a large scale. In the *Electrical Engineer* (Dec. 10) an excellent article is given, in which the whole process of manufacture of the chlorid accumulator is minutely described, numerous illustrations of the plant and processes reproduced from photographs accompanying the text.

Long-Distance Telephony.

COMPARATIVELY few persons, even among those well versed in electrical matters, have any adequate conception of the amount of study, investigation, and experiment which has been necessary to bring the development of long-distance telephony to its present state of perfection. The present condition of the art is briefly but intelligibly summed up in an article by F. W. Dunbar in the *Electrical World* (Jan. 12). Diagrams are given of the arrangements of the circuits on a long-distance line, and also of an apparatus now in practical use by which the same wire may be used simultaneously for both telegraphic and telephonic service without the slightest mutual interference. This is done by inserting condensers in the telegraphic branches at each end, which freely permit telephonic vibrations to pass, but are impervious to the steady currents used in telegraphy, while, on the other hand, the telephonic instruments are screened from the effects of sudden changes of current at the beginning and end of each elementary telegraphic signal by means of "retardation coils." By a singular mistake the cuts representing the two systems have been transposed by the printer,—which may possibly cause some confusion in the minds of persons unfamiliar with the general subject.

Modern Underground Cables.

IN the *Electrical World* (Jan. 19) William Maver, Jr., has a paper giving a concise, but very complete and intelligible, account of the modern methods of manufacturing, testing, and installing underground electric cables,—an art which, in its present aspect, has practically been developed within the past ten years. The article is well illustrated with perspective views and diagrams showing the various machines and processes employed. Among the most effective illustrations are two arranged on the "deadly parallel" plan, showing a section of lower Broadway before and after the compulsory removal of the overhead electric lines in New York city. Surprise is sometimes manifested that it should be possible to replace the vast and intricate mass of overhead wires which formerly darkened the streets of the metropolis by a comparatively small number of subterranean ducts. The explanation is very simple, and is found in the fact that one hundred wires, which make a heavy burden for a pole line, can be stowed away in a single cable in a three-inch subway duct. One of the most curious facts in connection with this subject is the increasing use of paper as an insulator. Under proper conditions it is found to answer most purposes admirably, while its indestructibility and cheapness are important points in its favor.

A Municipal Electric Light Plant.

IT is a circumstance worthy of remark that, while there are already a considerable number of municipal electric lighting plants in operation in various parts of the country, nearly all of them are located in places where a private company could not have profitably undertaken to do the business. Now and then, however, we come across one of these small municipal plants which is exceptionally well managed and shows very satisfactory results. One of these, that at South Norwalk, Conn., forms the subject of an article in the *Electrical Engineer* (January 30). It is a street-lighting plant of 120 2000-c. p. arc-lamps, supplied by two dynamos of 60 lights each, driven by a 100-h. p. high-speed engine. The fuel used is a mixture of two parts bituminous coal and one part locomotive sparks, bought in car-loads from a railway company. The station is of brick with a slated roof, 40

by 66 feet, and capable of convenient enlargement if required in future. The average number of nights lighted per year is 309; the average cost of lighting per lamp per year, including interest and depreciation, $59.29; pounds of coal per light per night, 23.29. The operating force consists of a superintendent, an engineer, and a lineman, who are appointed by Electric Light Commissioners elected by the people for terms of three years. In the *Electrical Engineer* of February 6, Mr. A. E. Winchester, one of the Board of Electric Light Commissioners for the current year, publishes a communication, in which he states that he is no advocate of municipal electric-light plants, or of other municipal business institutions, except under the most favorable conditions, which, he is careful to add, "are seldom met with except in theory." He further states that which, to be sure, is already pretty well known,—that "the primary reason for this increase in municipal plants is largely due to schemers, who by glowing promises make a business of obtaining valuable franchises from progressive little cities, and in return establish a cheaply constructed plant with the expectation of unloading the stock at a handsome profit upon the citizens." If the citizens do not "bite," the non-residents who own the plant usually seek to curtail the cost of operation at the expense of good service, and meanwhile the protests of the consumers are unheeded by the owners, who believe themselves protected by their charter in a monopoly of the business. It is then, as a last resort, that the people begin to talk of a municipal plant. The establishment of the South Norwalk plant appears to have been due to some such condition of affairs as that above referred to. "The great enemies of municipal plants"—says Mr. Winchester—"are politics and partisanship." Exactly so, and politics and partisanship in American towns and cities are the rule, while the exceptions are few and far between. It is gratifying to be assured that the management of the South Norwalk plant is non-political; for the sake of the citizens who are served by it, it is to be hoped that it may long remain so.

IN this department last month was given an abstract of a published description of the electric-railway system of the Philadelphia Traction Company. In the *Electrical Engineer* (Jan. 9) appears an excellent illustrated account of another system in the same city,—*viz.*, the Hestonville, Mantua, and Fairmount Passenger Railway Company. The Philadelphians were slow in taking up electric railroading, but it would certainly seem that the delay which has enabled them to profit so largely by the experiences, fortunate and otherwise, of other people has not been without its compensations. Many of the details of the construction of this road are of much interest.

INDEX TO LEADING ARTICLES

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

*28454. The Light of the Future. John Gray (E R L-Jan. 4.) 1800 w.

*28492. Electric Energy for Town Lighting. Walter J. May (Inv-Jan. 5.) 700 w.

*28597. The Electricity Works at Yarmouth. Ill. (E E L-Jan. 11.) 5200 w.

*28626. Higher Voltage Lamps for Central Stations. G. L. Addenbrooke (E R L-Jan. 11.) 2400 w.

28680. The Frankfort-on-the-Main Municipal Light and Power Plant. Ill. G. J. Melms. (E W-Jan. 26.) 3000 w.

28706. Incandescent Lighting on the Meter System Compared with the Contract System. G. L. Cole (W E-Jan. 26.) 800 w.

28720. On the Degree of Incandescence of Lamps. M. A. Crova (E A-Jan. 26.) 1100 w.

28809. Incandescent Lamp versus Welsbach Burner. William Goetz (E R N Y-Jan. 30.) 2000 w.

28812. On the Units of Light and Radiation. A. MacFarlane. Read before the A. I. E. E. (E N Y-Jan. 30.) 1900 w.

28961. Interior Conduit and Interior Wiring. Charles E Burton (W E-Feb. 2.) 3000 w.

28989. Electric Car Lighting System on the New York and Brooklyn Bridge Railway. Ill. (S R G-Feb. 2.) 800 w.

We supply copies of these articles. See introductory.

29064. The Fredureau Light-Diffusing Globe. Ill. Abstract by V. M. Berthold of a paper read before the French Academy (E R N Y-Feb. 6.) 550 w.

29095. Electric Lighting for Carriages. C. W. Chancellor (W E-Feb. 9.) 1000 w.

29119. Electric Lighting in Mexico—The Plant of the Aquas Calientes Electric Light Company. Ill. George Heli Guy (E E N Y-Feb. 6.) 1600 w.

Power.

*28377. Electric Power in Southern Cotton Mills. A. F. McKissick (E Mag-March.) 2500 w.

28443. The Lake Simcoe Power Aqueduct. E. A. MacDonald (C Eng-Jan.) 1500 w.

*28455. Possible Improvements in the Supply of Electrical Energy. S. Z. de Ferranti (E R L-Jan. 4.) 1500 w.

28523. Niagara To-day. Ill. (E E N Y-Jan. 16.) 1200 w.

28535. Constant Speed Motors. Thomas J. Fay (E A-Jan. 19.) 1200 w.

28594. The Warden Power Building, Philadelphia, Pa. Ill. (E R-Jan. 19.) 2200 w.

*28598. Electrical Energy—What It Is! R. C. Shettle (E E L-Jan. 11.) 1000 w.

*28629. The First Polyphase Motor. Ill. S. P. Thompson (El-Jan. 11.) 500 w.

28705. The Chicago Edison Company—Its History and Its Work. Ill. T. C. Martin (E E N Y-Jan. 23.) 6000 w.

*28768. Design and Efficiency of Plant for the Transmission of Power by Electricity. W. C. Mountain (I & I-Jan. 18.) 2000 w.

28906. A Test of a 65-H. P. Motor. Thomas J. Fay (E A-Feb. 2.) 1100 w.

28909. The Eddy Street Power Station at Providence, R. I. Ill. George T. Hanchett (E W-Feb. 2.) 1400 w.

28958. Electrical Power in a Large Newspaper Establishment—The Philadelphia Inquirer. Ill. (W E-Feb. 2.) 900 w.

28959. Some Characteristics and Economies of Accumulators as Applied to Central Lighting and Power Stations. Ill. John R. Markle (W E-Feb. 2.) 1900 w.

28960. Hints Upon Daily Work About a Dynamo Plant. Pliny Norcross (W E-Feb. 2.) 3000 w.

29067. The Niagara Power Transmission Plant. Ill. Frank C. Perkins (E W-Feb. 9.) 3000 w.

29121. A Dynamo Safety Device for Abnormal Potential. Ill. Device of Messrs. C. T. Penton, C. C. Gartland and P. J. Casserly (E E N Y-Feb. 6.) 450 w.

Telephony and Telegraphy.

†28388. The Evolution of a Switchboard. Ill. Arthur Vaughan Abbott (B U W-Vol. I, No. 4.) 9000 w.

28394. Signing One's Name a Hundred Miles Away—Signatures that Will Be Recognized by the Banks—Are they Autographs? The Telautograph. Nelson W. Perry (E N Y-Jan. 9.) 1800 w.

28425. Paris London Telautograph Test (W E-Jan. 12.) 600 w.

28475. Long Distance Telephony. Ill. F. W. Dunbar (E W-Jan. 12.) 2000 w.

28524. The Postal Telegraph Company in the West. George Heli Guy (E E N Y-Jan. 16.) 1100 w.

28527. Transmitting, Recording and Seeing Pictures by Electricity. Ill. George R. Carey (E E N Y-Jan. 16.) 1000 w.

28531. The Telephone.—An Explanation of Its Modus Operandi.—The Musical and Speaking Telephones and their Essential Differences Described. Nelson W. Perry (E N Y-Jan. 16.) 2500 w.

28560. The Importance of the Fire Alarm Telegraph System. F. C. Stoves (F W-Jan. 19.) 1700 w.

28648. The Magneto Telephone.—Plain Directions How to Construct, at Small Expense, a Most Serviceable Instrument for the Residence or Office. Ill. Nelson W. Perry (E N Y-Jan. 23.) 2500 w.

28653. Means for the Removal of Electrode Surface in Telephony. Ill. Telephonist (E R N Y-Jan. 23.) 800 w.

28668. The New Telephone System in Paris. Ill. E. Hospitalier in La Nature (Sc A-Jan. 26.) 2700 w.

28879. Printing by Telegraph (B J C-Feb. 2) 900 w.

28942. The Mexican Central Railway Telegraph System. George Heli Guy (E E N Y-Jan. 30.) 900 w.

*28997. The Origin and Development of the Telephone Switchboard. J. E. Kingsbury (E E L-Jan. 25.) 8000 w.

29058. The Microphone or Battery Telephone Transmitter.—The Footfalls of a Fly Made Audible to Human Ears.—The Great Service Rendered to Science by this Simple Invention. Ill. Nelson W. Perry (E N Y-Feb. 6.) 2500 w.

Miscellany.

*28374. Electric Wiring and the Fire Hazard. F. E. Cabot (E Mag-March.) 3000 w.

28395. The Legal Status of Electrical Wires in the Streets. R. D. Fisher (E N Y-Jan. 9.) 1400 w.

*28396. An Electric Shock, by Lesser Columbus.—Descriptive of the House of Siemens. Ill. (Com-Dec. 26.) 16000 w.

*28450. The Future of Electricity. Sidney F. Walker (E E L-Jan. 4.) 1800 w.

*28453. High Pressure v. Low Pressure. Rankin Kennedy (E R L-Jan. 4.) 1600 w.

*28463. Electrical Engineering. Editorial (Eng L-Jan. 4.) 3300 w.

*28473. A Determination of the Specific Heat of Water in Terms of the International

Electric Units. Arthur Schuster and William Gannon (El-Jan. 4.) 1300 w.

28526. How Does Electricity Kill? E. B. Rosa (E E N Y-Jan. 16.) 1500 w.

28528. The Electro-Chemical Actinometer.—Its Discovery and Practical Uses. Prepared by V. M. Berthold from M. Ch. Marechal's Paper (E R N Y-Jan. 16.) 2800 w.

28546. The Making and Laying of Underground Cables. Ill. William Maver, Jr. (E W-Jan. 19.) 5500 w.

28558. Thomson-Houston Regulator Patent Declared Void.—Judge Grosscup's Decision (W E-Jan. 19.) 2000 w.

*28622. On the Electrical Resistances of Certain Poor Conductors. B. O. Peirce (E R L-Jan. 11.) 1800 w.

*28623. Local Action in Accumulators. G. Darriens (E R L-Jan. 11.) 1700 w.

*28627. On the Properties of Batteries Formed of Cells Joined Up in Multiple Arc. B. O. Peirce (E R L-Jan. 11.) 1000 w.

*28628. Is the Magnetic Quality of Iron Affected by Often Repeated Reversals? Professor Ewing (El-Jan. 11.) 800 w.

*28640. The World's Debt to Electricity. John Trowbridge (Ch-Feb.) 2500 w.

28654. The Best Metal for Field Magnet Frames. Alton D. Adams (E R N Y-Jan. 23.) 700 w.

28673. Electric Accumulators Under Pressure.—Messrs. Cailletet and Colardeau's Apparatus. Ill. (Sc A S-Jan. 26.) 1400 w.

28682. Electrical Medical Apparatus. Ill. Harry F. Waite (E W-Jan. 26.) 400 w.

*28737. The Walker-Wilkins Voltaic Battery. Ill. (E R L-Jan. 18.) 1200 w.

*28756. On the Retardation of Polarization in Dielectrics. Riccardo Arno (El-Jan. 18.) 800 w.

*28758. Professor Rowland on Modern Theories of Electricity. Oliver Lodge (El-Jan. 18.) 1800 w.

*28771. Inaugural Address of R. E. Crompton before the Meeting of Electrical Engineers (E E L-Jan. 18.) 9500 w.

28810. A Few Words on "Carrying Capacity" of Conductors. J. E. Talbot (E R N Y-Jan. 30.) 1000 w.

28944. Alternating Currents. E. J. Houston and A. E. Kennelly (E E N Y-Jan. 30.) 900 w.

*28972. Modern Electricity. Editorial (Eng-L-Jan. 25.) 2500 w.

*29044. Electrical Engineering in 1894 (E Rev-Jan. 21.) 1500 w.

29066. Electrical Difference of Potential. William A. Anthony (E W-Feb. 9.) 800 w.

29068. Electrical Consonance. M I. Pupin (E W-Feb. 9.) 1800 w.

29069. How to Build a Rheostat—For Amateurs. Ill. G. E. Dunton (E W-Feb. 9.) 1000 w.

29070. Dry Batteries. L. K. Böhm (E W-Feb. 9.) 1200 w.

†29079. Discussion of Ludwig Gutmann's Paper—"The Production of Rotary Magnetic Fields by a Single Alternating Current" (T A I E E-Jan.) 5000 w.

Serials

22059. Practical Notes on Dynamo Calculation. Ill. Alfred E. Wiener (E W-Began May 19—28 parts to date—15 cts. each).

22131. The Incandescence Lamp. A. Bainville (E R L-Began May 11—8 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W-Began July 21—25 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Ill. Newton Harrison (E A-Began Aug. 25—20 parts to date—15 cts. each).

25095. Postal Telegraphs. Ill. James Bell (E L-Began Sept. 7—21 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y-Began Sept. 19—17 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L-Began Oct. 5—17 parts to date—30 cts. each).

25907. The Alternating Current; Its Generation and Distribution. Ill. George D. Shepardson (E I-Began Oct.—4 parts to date—15 cts. each).

26592. Electrical Power Transmission. Louis Bell (E W-Began Nov. 10—12 parts to date—15 cts. each).

27371. The Electric Light. Ill. Henry Stooke (I C B-Began Nov. 23—10 parts to date—30 cts. each).

27506. Suggestions in Preparing Specifications for the Electric Lighting of Buildings. Nelson W. Perry (E R-Began Dec. 8—3 parts to date—15 cts. each).

27704. Some Hints on the Building of Electric Plants. Charles G. Armstrong (E I-Began Dec.—2 parts to date—15 cts. each).

27855. Methods of Determining the Efficiency of Dynamos and Motors. Ill. J. Reginald Ashworth (E P-Began Dec.—2 parts to date—30 cts. each).

28624. The Testing and Inspection of Electric Light Cables. Anon. (E R L-Began Jan. 11—Ended Jan. 25—2 parts—30 cts. each).

28759. The Electric Arc. Ill. Hertha Ayrton (El-Began Jan. 18—2 parts to date—30 cts. each).

28811. The Distribution of Energy in the Spectrum of the Glow Lamp. Edward L. Nichols (E N Y-Began Jan. 30—2 parts to date—15 cts. each).

29041. The Recent Growth of Electrical Engineering. S. Flood Page (E Rev-Began Jan. 21—1 part to date—30 cts).

29132. Magnetic Mechanism. Ill. Wilbur M. Stine (E A-Began Feb. 9—1 part to date—15 cts).

INDUSTRIAL SOCIOLOGY

The Independent Labor Party.

OF the recent movements that have their origin in the restless spirit now pervading the laboring classes, the formation in England and Scotland of the Independent Labor Party, its successful attempt to effect an efficient organization, and its rapid growth in numbers and influence, are among the most significant. This party is unconnected with either Liberalism or Toryism. It effected its present organization in 1893, and its existence may be taken as dating from a conference held at Bradford in that year, at which one hundred and twenty delegates from different parts of the kingdom were present. This convention seems likely to become historic. Mr. J. Keir Hardie, M. P., in the *Nineteenth Century* for January, has presented a full account of the origin, growth, organization, and political creed of this new party.

Prior to 1893 fitful and unfruitful efforts to establish a party had only resulted in multiplying candidates who received small support at the elections. There were quite a number of so-called "Independent Labor Organizations," but each acted by itself, and there was no plan for securing concerted action. The Bradford convention in 1893 brought all these associations into a single organization, which, together with accessions to its numbers since that meeting, now numbers over fifty thousand. "A second conference was subsequently held in Manchester in February, 1894, at which none but representatives from branches which had affiliated to the Independent Labor Party were admitted. Ninety-four delegates attended, some representing several branches. Again the conference sat for two days, and the programme agreed to at Bradford was slightly amended. Since then the movement has gone on developing by leaps and bounds, and in a directory just issued by the secretary, Mr. Tom Mann, a full list of branches in all parts of the country is given. In Lancashire and Cheshire there are 68 branches; in Yorkshire alone, 101; Scotland is represented by 40; London has 30; the Midlands, 21; North-eastern counties, 15. There are several branches in Wales and 2 in Ireland. The total number of branches presently existing is over 300, comprising a total membership of over 50,000."

Each member pays a minimum of 1 penny per week as his contribution to the treasury of the organization, but the average is 3 pence per week, which results in a yearly collection of £32,500. Aside from this, liberal sums have been specially contributed for election expenses by members and friends of candidates. "Many working-men, earning not more than 25 or 30 shillings per week, have contributed from 10 to 20 shillings toward these bye-election funds."

The voting strength of the party is said to much exceed its financial membership. And as an example of this, the case of Mid-Lanark in the April election is cited. Here, with a membership of 100 candidates, the party received 1221 votes. In Leicester, where, previous to the election, no branch had been organized, the Independent Labor Party candidate received 4402 votes.

"The organization of the party proceeds on the following lines: in each constituency one branch is recognized, which, however, may be divided into ward or parish sections for the purposes of organization. These branches are affiliated to 'county federations,' or, in the case of boroughs, into 'councils'; such councils and federations supervising the work over the entire area covered by the branches represented thereon. A conference is held yearly of one representative from each branch. This conference is the supreme authority for the whole organization. Its decisions are binding alike upon branches and members. From this annual conference president, secretary, treasurer, and a committee

of six are selected. These form what is known as the 'National Administrative Council,' which continues in office until the next conference is held. This council is purely administrative and may not initiate any new policy without the sanction of the conference. In addition to carrying out the decisions of the conference at which it was appointed, the council is expected to raise funds for the general work of the party, and a special election fund to aid branches running candidates."

The object of this organization is formulated as, "the collective ownership and control of the means of production, distribution, and exchange"; and the methods by which the object is to be attained are "independent representation of the people in the house of commons and in all legislative, governing, and administrative bodies, and by propaganda by means of literature and public meetings."

The conditions to which a candidate must subscribe before the new party will accord him its favor and financial support are: "(1) that he will advocate the object and programme of the Independent Labor Party; (2) that, if returned to parliament, he will form one of the Independent Labor Party there, and sit in opposition, without regard to the political color of the party in power; (3) that he will act with the majority of the Independent Labor Party in the house of commons, irrespective of the convenience of all other political parties. In selecting candidates, each branch must obtain the consent of the national administrative council of the party before their candidate can be recognized."

Law of Corporations.

To Judge Gaynor, of Brooklyn, N. Y., not only the State of New York, but the whole country, is indebted for the firm, wise, and equitable stand he has taken on important issues, and his calm, unbiased, impartial administration of justice since he has been on the bench. His recent decision in the matter of the application of a private citizen for a mandamus to compel the Brooklyn Heights Company to run its cars, which was one of the most important incidents of the great strike of the employees on the electric street railways of that city, will do much toward relieving the traveling public from the embarrassments accompanying such strikes, while, at the same time, it wrests from corporations one of the most powerful weapons by which they have hitherto resisted the demands of employees.

In the case of the Brooklyn strike there can be no question that the men asked for nothing unreasonable or unjust. That their demands were resisted so long by some of the corporations was due to the fact that these corporations illegally suspended the operation of their roads, to the great inconvenience of the public, and to the serious injury of business, both in Brooklyn and New York. What Judge Gaynor says in his decision of the Brooklyn Heights Company applies equally to all railway corporations. Their first duty, he says, is to the public, and not to their stockholders. The following extract from the decision, as printed in the New York *World* (Jan. 25), very clearly states the relations of these corporations to the public:

"It is my duty to declare the law of this case. This railroad corporation is not in the position of a mere private individual or company carrying on business for private gain, which may suspend business temporarily or permanently at pleasure. On the contrary, it has a dual relation,—a public relation to the people of the State and a private one to the stockholders.

"It must not be forgotten here, though it may seem to be growing dim, if not wholly forgotten elsewhere, that in its chief aspect it is a public corporation, having duties to perform to the public which transcend any obligation which in its private aspect it owes to its stockholders. It has received franchises of great value from the State, and had conferred on it the State's transcendent power of eminent domain. In return it took upon itself the performances of public duties and functions, in the performance of which it is in law and in fact not an independent individual or entity, but the accountable agent of the State.

"Though these principles are old and inherent in the idea of the sovereignty of

the people, it would seem that in the recent rapid growth of corporate power, and of the tendency to use public franchises for the aggrandizement of individuals first, and for the service and benefit of the public second, they have come to be somewhat overlooked, and need to be restated. They have often been declared by the higher courts of this State and the Supreme Court of the United States (Olcott vs. the Supervisors, No. 16 Wall, 687, 694; Bloodgood vs. Mohawk, &c., R. Co., 19 Wend., 9; The People vs. N. Y. C. and H. RR. Co., Hun., 543). The duty of the company now before the court is to carry passengers through certain streets of Brooklyn, and to furnish, man, and run cars enough to fully accommodate the public. It may not lawfully cease to perform that duty for even one hour.

"The directors of a private business company may, actuated by private greed, or motives of private gain, stop business and refuse to employ labor at all unless labor comes down to their conditions, however distressing, for such are the existing legal, industrial, and social conditions. But the directors of a railroad corporation may not do the like. They are not merely accountable to stockholders; they are accountable to the public first and to their stockholders second. They have duties to the public to perform, and they must perform them.

"If they cannot get labor to perform such duties at what they offer to pay, then they must pay more, and as much as is necessary to get it. Likewise, if the conditions in respect of hours or otherwise which they impose repel labor, they must adopt more lenient or just conditions. They may not stop their cars for one hour, much less one week or one year, and thereby beat or coerce the price or conditions of labor down to the price or conditions they offer.

"In respect to the question of hours and wages between the company and its employees, its duty was to have gone on, and it is to go on with its full complement of employees, having the right gradually and from day to day to supersede its employees, if it can, by new employees who will work on its terms, or to supersede them all at once when it has obtained a sufficient number of new employees for that purpose; but in such a controversy it has not the right to stop its cars while it is thus gradually getting other men.

"If the people of the State were running these roads, they would not thus incommode and damage themselves, and it must not be forgotten that this corporation is intrusted with the running of these roads as the servant of the people of the State.

"It therefore only remains for me to determine the form of the writ."

The New York *World*, Brooklyn *Eagle*, and other papers, commenting editorially upon this decision did not dispute its legal accuracy, but asserted that the Brooklyn roads were not able to run their cars as a matter of fact, and that neither corporations nor individuals can be legally forced to do impossibilities. But the fact is that, if their employees had been justly treated, there would have been no interruption of traffic, and at any time the strike would have terminated by conceding to these men what they demanded. There was no impossibility in this. What the companies did was to run some cars under difficulties, and let the public wait for what Judge Gaynor states should have been constantly supplied. No one believes that the entire force of striking employees on the Brooklyn roads could have been replaced in one hour, or one week, even if there had been no violent opposition to such an attempt. The real impossibility was in getting new men, but, according to the decision, this was no excuse for the failure of the companies to run their cars. However, Judge Gaynor, doubtless glad of the opportunity to shift the responsibility this interpretation of the law entailed, availed himself of a technicality, and on a question of fact raised by the Brooklyn Heights Company, allowed it twenty days to show cause why a peremptory mandamus should not issue.

Migration of Population.

THE tendency in the discussion of labor disturbances to single out some one social tendency and to set this up as the controlling factor is one of the peculiarities of the

current debate kept up by magazine writers upon the "burning question." Thus Mr. Geoffrey Drage, in the *Fortnightly Review* for January, under the title "Alien Immigration," assumes, or, rather, asserts, that "experience points to the inevitable acceptance of the migration of population as a determining factor in the labor question," and maintains that it points also to the desirability of leaving that migration as free from artificial stimulus as from arbitrary limitations. Therefore the logical conclusion must be that, if migration be not meddled with, either in the way of help or hindrance, it will of itself work out the solution of the problems that now perplex the industrial world. If migration be "the determining factor" and its influence be not interfered with, it will certainly determine the future of industry. All we have to do then is to wait and endure present ills, until migration has done its perfect work. How long we shall probably have to wait and suffer is not intimated by Mr. Drage. From all that can be gathered it appears to be a very slow process indeed, and meanwhile the content of the laboring classes does not increase. On the contrary, discontent grows and threatens. But, although this shifting of population is the grand panacea for social ills, and although it must not be stimulated or obstructed, but left perfectly free to operate in its own way, it is admittedly not "a matter of indifference to the governments of Europe or of any other continent. On the contrary, it is clear that outside England it calls for the most urgent attention, whether the question at issue be the European movement from east to west, or whether it be the tendency of the yellow races to spread themselves eastwards over the shores of the Pacific or southwards through Malaysia into Australia. These two great movements of the European and Mongolian peoples, together with the immense migration from India to the Crown Colonies and to Africa, and the spread of the black races in America, constitute in its broad outlines the population question, and therefore the labor question of the future. In Europe the Latin races of the South and the great Slavonic peoples of the East are gradually pressing the Teutons within narrower and narrower limits. Italy has, indeed, recently made some attempt at internal colonization, but the Italians still come in their thousands into Austria, just as they pass northwards into Switzerland. The Russian government may desire an expansion into Siberia, but the great massing of the Slavonic peoples is upon the Teutonic frontiers; they are expanding, as the peoples of Eastern Europe have always expanded, westwards, whilst the peoples of Western Europe emigrate wholesale to America. The vast emigration from Scandinavia is making room for a Slavonic advance, slower certainly than the advance further south, owing to difficulties of climate, but still taking its share in the gradual supplanting of Teutonic labor and Teutonic civilization." In conclusion, it is claimed that alien immigration into England scarcely deserves to be compared with that received by other countries, and that England is happily free from the problems which beset its continental neighbors and from "the pressing industrial competition which American workmen allege as a reason for demanding protection"; but it does not clearly appear that Mr. Drage has succeeded in establishhis thesis that the solution of the labor question is to be worked out by the migration of population, and that this should be left entirely free from interference.

The Industrial Situation.

WHAT is the matter with the commerce of the world? Everyone is seeking to answer this question, and numerous causes are assigned, each of which is regarded by the person offering it as ample to account for the present status. The year 1895 begins under most peculiar conditions. Abundant wealth and abundant poverty exist, with apparently no commercially practicable way open whereby capital can be so used for the benefit of labor as to relieve either of its present idle surplus. The idle surplus both of capital and labor is the problem which now confronts the nations. In an editorial, *The Engineer* (London, Jan. 4) takes a common view of the situation, but, as usual in

articles of this sort, fails to grasp the question in its entirety. The fault is considered to be all on the side of labor. If labor would concede to capital all that the latter requires, the difficulty would be ended. Labor can get all the employment it desires, if it will accept it on the terms offered by capital.

"There is in this country—and, we may add, in the United States—a great mass of capital seeking employment, and for two principal reasons this capital will not be used. The first is that engineers appear to be unable or unwilling to suggest an outlet for it; the second, and by far the more important, is that capitalists have no confidence whatever in the common sense and ability of labor leaders. The capitalist regards the labor leader as a mischievous windbag. Now, as a rule, the capitalist is a very shrewd man of business; if he were not, he would not be a capitalist. He likes to coöperate with sensible men, and he abhors dealing with fools. Up to the present no labor leader has started on commercial lines; not one has shown that he possesses the knowledge, the mental stamina, or the influence requisite. Suppose that to-morrow such a man came forward, and proved that he could lead and control five thousand or ten thousand men, and that he could place them, on terms to be rigidly carried out, at the disposal of a syndicate of capitalists; is it to be imagined that the money would be lacking to carry out a great enterprise? Not for a moment. The truth is, if the labor leaders could only see it, that they can have all the capitalists in the kingdom working eagerly with them, if they will give them a chance. But this is just what the labor leaders will not do, because they permit sentiment, and fancied wrongs, and wild notions manufactured in Poland, Hungary, Italy, Russia—countries which have nothing in common with Great Britain—to usurp the seat of common sense. If only they could once see that the reason why a man becomes a capitalist is that he flings such ideas to the winds, and deals with the world as it is and not as it ought to be, and, taking a lesson from him, would understand that such things as strikes on a falling market are blunders, and that labor can have the use of any amount of capital it thinks proper to enjoy if only it will go the right way to work, then would a new era open, and trade would once more advance by leaps and bounds."

It is pointed out that the efforts of labor to improve its condition by the method of strikes in 1894, have almost all been failures. "Strike after strike has collapsed because they were started without any knowledge of the prevailing conditions of trade." While this may be admitted as a strong argument against the wisdom of the method of strikes, it cannot be accepted as proof that labor-leaders are "fools," that labor suffers only "fancied wrongs," that its notions are all "wild notions manufactured in Poland, Hungary, Italy, Russia," or that "sentiment" should find no place in the adjustment of existing issues. So long as the scope of sentiment, which is the basis of all charity (it might also be said to be the basis of ethics), is confined to public and private effort for the relief of want, just so long will the present strained relations between capital and labor continue and increase. It is this mischievous principle—that feeling has no place in business—which is working out the evil tendencies of the age. A man is not a mere machine without feeling. This cult of supreme selfishness has already wrought enough woe in the world. It is time that in business, as well as in private intercourse, some regard to the welfare of others should be considered essential to that morality which can command public approval.

The Future of American Shipping.

THE disabilities under which the shipping interests of the United States at present labor, and the proposed remedy,—discriminating duties,—are discussed by Mr. Richard P. Joy, in *Seaboard* (Dec. 13). The present Democratic congress is charged with "retrogression instead of progression," and the president is styled a "superficial observer" in consequence of his speech at the launching of the *St. Louis* at Philadelphia a few weeks ago, wherein

he favored the free-ship bill, and wherein he asserted that the *St. Louis* was the result of the relaxation of our present registry laws. Mr. Joy asserts that "the owners of those ships would never have asked congress for an American registry had it not been for this act. It was a special case, and one which should not be repeated, for it was the entering wedge for free ships, and a dangerous precedent. Should congress pass a free-ship bill, would it help our marine? Could Americans operate against the low wages paid foreign seamen, and against the heavy bounties, mail subsidies, and subventions which foreign governments have granted their shipping? American shipowners have told me that they cannot, and, that no matter where a ship is built, it is folly for them to engage in any trade but the protected coastwise trade. If congress should pass the free-ship bill, as Mr. Cleveland advises, it would strike a savage blow at the American coastwise trade, for congress cannot dictate what trade a ship under the American flag shall enter."

It is plain that the argument represents the views of that class of economists who believe that legislation favoring special commercial interests is the great panacea for particular industrial ills. Mr. Joy says he has, in the past, advocated discriminating duties as a remedy, and he still believes that it is "the duty of congress to abrogate the treaty which binds by honor the American nation, notwithstanding the repeated violation of it by England. Britain is honorable in commercial matters only as long as she pleases. If anything is to be gained by dishonest policy, she will not let such a small thing as honor stand in the way."

As to the retaliation of other countries —England, for instance—should the legislation advocated be carried out, the reply of this school of economists is that they would not dare to do this. "Should England retaliate with a like system of duties on American exports, such as beef, pork, grain, and breadstuffs, the cost of living to the labor of England would be increased, and this Britain specially desires to avoid, for she must admit all the necessaries of life free (as she cannot raise them herself) in order to cheapen the cost of manufacturing. This policy is the very corner-stone of England's supremacy. If the British government destroy that policy, the whole commercial supremacy of that country falls." This argument presents nothing new, and it rests wholly upon the principle of protection, as that term is understood by protectionists of the radical sort. Under not improbable political changes the system advocated may meet with increased favor.

A Phase of Foreign Competition.

IN an editorial in *Engineering* (London, Jan. 12) referring to the Belgian competition with the English iron industry, the following incident, quoted from correspondence of the *Times*, is narrated. Mr. J. W. Durnford, an architect, wrote to that journal stating that a building contractor placed an order for an iron girder of simple construction with a firm in a certain town. Through delay in delivery, inquiries were made, in the course of which the following remarkable circumstances came to light. The first firm, A, had passed the order on to firm B, who had passed it on to firm C—A, B, and C being English houses in business in midland towns. Finally, the firm C sent the order to a Belgian firm."

In commenting upon this curious shifting of contracts, *Engineering* thinks "it does not much elucidate the problem of foreign competition," although it emphasizes very strongly the fact that foreign competition exists and is strong.

The reason why Belgium and Germany furnish girders for British buildings is said to be that architects and engineers "generally specify such unnecessarily diverse types of sectional material for given work that anything like economical and continuous manufacture becomes impossible. On the continent schools of engineers have determined amongst themselves upon a range of sections of rolled iron and steel suitable for certain duties in given types of work." The introduction of Belgian iron and steel in English

markets probably has a wider significance than this rather weak explanation indicates. If the diversity of types spoken of embarrasses English manufacturing, it is not obvious that it would not also similarly affect Belgian and German makers, and this explanation seems much like whistling to keep up courage.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*28386. President Cleveland's Currency Scheme. W. R. Lawson (B M-Jan.) 6500 w.

*28387. Low Interest and Plenty of Money. (Extract.) Alexander John Finlaison (B M-Jan.) 2700 w.

†28413. The Independent Labor Party. J. Keir Hardie (N C-Jan.) 5800 w.

28422. The Nicaragua Canal. (Abstract of article in N Y. Journal of Commerce.) (R G-Jan. 11.) 1800 w.

†28456. Alien Immigration. Geoffrey Drage (F R-Jan.) 4000 w.

28657. Profit Sharing. Editorial (Ir Age-Jan. 24.) 600 w.

*28688. Tariff Changes and Customs Regulations. Russia, Germany, France, Spain, Italy, United States, Brazil, Ecuador, Peru, Argentine Republic, British India (B T J-Jan.) 6000 w.

28703. The Labor Laws of Belgium (E N-Jan. 24.) 900 w.

*28725. A Phase of Foreign Competition. Editorial (E-Jan. 18.) 1500 w.

*28764. A Dutch Co-operative Town—Agneta Park. From the London Times (I C B-Jan. 18.) 1300 w.

28777. Street Railway Strike in Brooklyn. Ill. (S R G-Jan. 26.) 4000 w.

†28792. Some Material Forces of the Social Organism. John W. Langley (P S M-Feb.) 5000 w.

28796. The Conflict of Labor and Capital. J. J. Ingalls, in the Post-Express (R R-Jan. 26) 1200 w.

*28813. Money. James A. Quarles (A M C-Feb.) 7800 w.

*28814. What Is Prison Reform and How Does It Concern the Public? W. C. Selleck (A M C-Feb.) 3500 w.

*28815. The Catholic Church and the Coming Social Struggle. Charles Robinson (A M C-Feb.) 2500 w.

*28816. Economic Coöperation. E. M. Burchard (A M C-Feb.) 2500 w.

*28817. Suffrage for Women. Mary Elizabeth Brooks (A M C-Feb.) 4000 w.

*28818. The Coming System of National Credit. A. C. Houston (A M C-Feb.) 3600 w.

*28820. The Republic: Endurance by Means of Revolution. William Macomber (A M C-Feb.) 2300 w.

*28823. The Mohonk Conferences. Frances C. Sparhawk (A M C-Feb.) 2600 w.

28824. Why Northern Wealth Grows Faster Than Southern. Anon. (S Ec-Feb.) 3500 w.

28825. French View of Socialism. (Extract.) Leon Say (S Ec-Feb.) 2500 w.

28826. Fallacies That Fool Fiatists. I. W. Porter, with Editorial Reply (S Ec-Feb.) 3500 w.

28827. Judicial Ignorance of the Law (S Ec-Feb.) 500 w.

28828. Spencer's Ethical System. Van Buren Denslow (S Ec-Feb.) 1800 w.

28829. Social Conditions at the South. G. F. Milton (S Ec-Feb.) 2000 w.

†28830. The Financial Muddle. I. J. Sterling Mortimer. II. William M. Springer. III. Henry W. Cannon (N A R-Feb.) 12500 w.

†28831. Politics and the Farmer. Benjamin F. Clayton (N A R-Feb.) 2500 w.

†28832. Problems in the Indian Territory. Orville H. Platt (N A R-Feb.) 2800 w.

*28839. Should the Government Retire From Banking? W. C. Cornwell (F-Feb.) 2500 w.

*28840. Why Gold Is Exported. Alfred S. Heidelbach (F-Feb.) 1800 w.

*28841. The Programme of German Socialism. W. Liebknecht (F-Feb.) 4800 w.

28872. The Mandamus of the Brooklyn Strike. Editorial (R G-Feb. 1.) 1500 w.

28886. Relocation Necessary—Friction in Our Mechanism of Exchange Is the Bottom Cause of Present Depression. George B. Cowlam (M R-Feb. 1.) 1800 w.

28908. The Story of the Brooklyn Strike. Ill. (E W-Feb. 2.) 2000 w.

28938. The Hon. Thomas B. Reed on "Wealth." (B I S-Jan. 30.) 2400 w.

*28965. The Government and Fair Wages in Engineering Firms. Editorial (E-Jan. 25.) 3000 w.

*28966. The Industrial Situation. Editorial (E-Jan. 25.) 2100 w.

†28984. The President's Currency Plan. W. J. Bryan (A-Feb.) 4200 w.

†28985. Bimetallism and Legislation. C. S. Thomas (A-Feb.) 5800 w.

28991. Inland Waterways—Their Development an Important Factor in the Progress of the South. Anon. (T-Feb. 1.) 2500 w.

29096. The Brooklyn Strike. "Matthew Marshall" in the N. Y. Sun (W E-Feb. 9.) 1200 w.

Serials.

28842. The Social Discontent. I. Its Causes. Henry Holt (F-Began Feb.—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Rule of the Road at Sea.

UPON this important subject, increasing constantly in importance as the number and speed of steamships increase, a spirited debate is reported in *Fairplay* (Jan. 11), the subject having been brought before a meeting of shipowners, merchants, and shipmasters, held at Liverpool on January 8, by an address of the lord mayor, who presided over the meeting. He said that the substitution of steam for sailing vessels had very naturally rendered necessary a reconsideration of the rules at sea, and the Board of Trade had very properly endeavored to meet the altered circumstances by a conference of the maritime powers held at Washington in 1889. Here a code of rules seemed to have been fairly discussed and decided upon, and, as far as he could understand, with practical unanimity, except on two points,—one of these having reference to side-lights of ships, and the other to the form of fog signal to be used at sea in the presence of fog or weather calling for the use of that sign. By the multiplication and duration of a sound signal the captain of a vessel could be supposed to know whereabouts and in what direction another vessel was steering. Upon these two questions a strong difference of opinion exists. At the conference itself 64 per cent. of the representatives objected, and only 29 per cent. approved of the suggested proposals; and—what was still more remarkable—the entire voice of the Liverpool shipowners' associations, the committee of Lloyd's, and many other interested organizations (all of whom might be fairly supposed to be as fully alive to their own interests and the safety of their vessels as the Board of Trade officials) condemned these rules in the strongest possible terms. They hold that, instead of diminishing risk at sea, they would increase it; that they imposed upon captains of ships at a critical moment, when all their faculties were needed in other directions, duties which it would be practically impossible for them to carry out. To those cogent arguments the Board of Trade turned a deaf ear. All parties agreed that there was room for improvement; that, if a simple and efficient indication by light or sound of the position and course of steamships could be devised and agreed upon, it would be an immense gain to all interested; and that it would further seem reasonable that no fresh legislation should take place until all parties were fairly well agreed upon these points.

Mr. T. Gibson Bowles, M. P., said they had been driven there that day by the arrogance of the Board of Trade and by the determination of that department to listen to no representations made by practical men as to the carrying out of the rules which they were called upon to work. The dangers which were to be imposed upon the shipping industry of the country were so great that they could not and dare not remain any longer silent. The subject affected not only the lives of a quarter of a million of British seamen, but property and many other matters. Of course, there were difficulties in the way of getting this matter dealt with. In the House of Commons, if the words "rule of the road" were mentioned, the members, including even the president of the Board of Trade, flew away either to the dining or tea rooms. The Board of Trade seemed to forget that British seamanship was 2000 years old. Signals, in some cases, were very necessary; but, after all, they were only auxiliaries to the rule of the road. The old rule was plain and simple. The vessel that had another on her starboard side had to give way, and that was the rule up to the year 1863. In fact, the whole of the rules of the road were learned from the sea, and were kept short, simple, plain, and undoubted; and, until the Board of Trade began to interfere, it was possible to put

the whole of the rules on a sheet of note-paper. It was about the year 1853 that the Board of Trade began, through powers obtained from the merchant-shipping act, to interfere with the rule of the road at sea, taking in course of time the rules into its own hands. Hence arose all these troubles. In 1862 a code of regulations was drawn up, and in that code the old rule that one vessel was to give way to another was abandoned, and the words "should keep out of her way" were introduced. This, of course, created uncertainty and formed an element of danger. Since the time he had mentioned scarcely a year had passed without some small, niggardly alteration being made. In his opinion, the Board of Trade was a kind of departmental cuckoo, which laid its eggs in everybody's nest and produced the most fearful wild fowl.

As to the qualifications of the Board of Trade to formulate rules for marine service, he stated that the former president of the board was a weaver, and the present president a historian, who had to rely upon subordinates, many of whom had perhaps been to sea thirty years ago, but had probably lost their knowledge of the sea in the interval since. He criticised the opinions of Lord Farrer and Mr. Thomas Gray, and said that, according to Mr. Gray, steamers were to be placed in the same category as cabs or omnibuses. Apparently Mr. Gray could not conceive that a ship was a different kind of thing, which cannot be handled as the pedestrian or the omnibus and the cab. The Board of Trade had to obtain the sanction of the admiralty before it could alter any rule, and he was strongly of opinion that the course of the admiralty in invariably endorsing all that the Board of Trade did was a grave dereliction of duty. Speaking of the losses at sea by collision, he pointed out that, while in the years from 1871 to 1875, out of 3513 British ships totally lost at sea, 286 were lost by collision, during the years 1889 to 1893, out of 2451 total losses, 425 ships were lost by collision. These figures showed the large increase in losses by collision; for, while twenty-three years ago one out of twelve ships was lost by collision, now one out of six was so lost. The rules made to prevent collisions were inefficacious and bad.

Their complexity and length, and the many changes that have been made in existing rules, were criticised. The Washington conference was also severely criticised as "utterly inadequate to frame any code of regulations." "In his opinion it would be necessary to revert to the shortness, simplicity, and certainty of the old rules; and they would also have to put into the melting-pot all these new rules, and get a few practical men together to make a new code for the seamen."

Bilge Keels.

ONE of the features of modern marine engineering is the increasing favor with which bilge keels are regarded. The influence of these keels in preventing the rolling of vessels at sea is very marked, and it has also been found in modern yacht-construction that such keels will enable a sailing vessel to stand up to the wind under a heavier press of sail than would otherwise be possible. Another effect is the prevention of slip which occurs in heeling over under wind pressure, in which case the bottom keel does not hold advantageously against the water.

In connection with the influence which rolling of ships may have upon the issue of a naval combat, as illustrated in the engagement between the Chinese and Japanese fleets at Yalu, the influence of bilge keels is broadly discussed editorially in *The Engineer* (London, Jan. 18). The mathematical discussion of the resistance of bilge keels occupies a considerable space in the article, and we shall notice only some of the examples referred to as illustrating their practical effect.

"Sir W. H. White quotes, as an illustration, the work done by the bilge keels of the *Sultan*, which are 420 square feet in area, the period of rolling being longer, and the angle of heel during the single swing quoted being 0.102 circular measure, presumably between 5° and 6°. Under these circumstances the amount of work done appears to be only 1890 lbs. Hence the assistance afforded by the bilge keels of the *Royal Sovereign*, or *Magnificent*, to-

wards the extinction of rolling when the vessel has heeled 17°, is one hundred times that afforded by the smaller bilge keels of the *Sultan* at an angle of heel of between 5° and 6°. The importance of large bilge keels when a ship is rolling heavily can, therefore, be hardly overestimated, we are inclined to think.

"There is, however, another aspect of this question which may accentuate still more sharply the immense importance of the bilge keel as a constructive feature. It has been conclusively proved that the rate of extinction of rolling of ships under weigh is more rapid than that of ships having no headway. A table quoted in Sir W. H. White's work gives the increase of rapidity in the process of extinction between no headway and eight knots' speed, in a particular vessel, as 50 per cent. The explanation suggested is as follows: 'When the ship is under weigh, she penetrates at each instant into water not yet disturbed, of which the whole inertia has to be overcome, whereas, when she has no headway and is rolled, similar conditions do not hold, and the inertia of the water is not so great.'"

Other examples are cited of ships loaded with live stock whose trampling set up a decided rolling when the vessels lay moored at the side of their docks, although these vessels were steady enough when under weigh. The principle seems clear that, when these keels penetrate water which is practically at rest, the inertia of the water is a factor in the effect they produce. "It seems irrational to suppose that, when such a mass as a vessel weighing many thousand tons is under consideration, a pressure of 1890 lbs. upon the bilge keels would present any effective resistance to the influence of rolling; but, when the size of the bilge keels and of the ship itself increases, so as to make the work done fourfold greater, and when the rapidity of the rolling motion is enhanced so greatly as to develop this work of resistance fifteenfold, still further, the figure of 105 tons stares us in the face. This is by no means a figure to be despised. It is well known that three hundred men, who would weigh about 22 tons, can set a heavy battleship rolling by running simultaneously across the deck. It is reasonable therefore, to suppose that a pressure of 105 tons exerted against an unbroken water surface would possess immense influence in the bringing of a ship to rest after she had started rolling. The same pressure, in its initial degree, would tend to prevent the setting-up of this process."

Electroplating Ships' Hulls.

ELSEWHERE we have remarked that the industrial uses of electricity seem inexhaustible. One of the most important of recent innovations is the electroplating with copper of the hulls of iron vessels. Should the method prove entirely practical, as it certainly seems to be, it will result in large economy to the mercantile marine of the world, and it will, of course, be equally valuable to war-vessels. A vessel 98 feet long has recently been thus electroplated by the Ship Copper-Plating Company of New York, and the operation and method were illustrated and described in the *Scientific American* (Jan. 26). A continuous coating of inch in thickness was thus put on the vessel over "the entire surface below the water line, including the riveted laps of the steel sheets, the keel, the stern, and rudder post." The operation is described as follows:

"The method is a triple one. The bath, which in size is about 5 feet square, is securely placed in position, and, after being shored up against the vessel's bottom, is calked around the edges with cotton and oakum till it is water-tight. Then it is filled with strong acid solution of copper cyanid, and a current of 6 volts and 900 amperes is applied. The action of the cyanid solution is two-fold; it assists in cleansing the plates, and also causes a firm film of copper to adhere in the next stage of the process. The cyanid bath is removed after having been allowed to act for twenty-four hours, and a solution of copper sulphate is substituted. Large copper plates are used as anodes; the current is reduced to 3 volts, and the amperage remains the same. The deposition of copper takes place immediately, and the process continues until copper has been de-

posited to the thickness of from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch; the current is then stopped, and the bath removed. The deposition of the copper usually requires about 4 days. The coating is closely adherent, and cannot be removed except by chipping with a cold chisel, in which case a portion of the iron usually comes away with it. The lapping of the coatings has been already described. There is no chance for galvanic action to set in, except by a blow, or grinding upon a rock, which might cut through the film. But, after such a blow, the vessel would undoubtedly have to be docked for repairs, and a small bath could be applied to re-copper the defective spot. The plating of propellers will be of particular value, as the least bit of corrosion interferes seriously with their efficiency. Of course, in practice, a large number of tanks or baths would be in use, and it is expected that an ocean steamer of the largest size (600 feet long) could be completely plated in 4 weeks.

"Experiments have been made on the copper coating, using sea-water which has been brought from ten miles out at sea; it is found that this water has no effect on the coating. To Mr. Henry Bergfels, the plater of the tug, much credit is due in the way of overcoming difficulties, which naturally arise in a new undertaking of this description. It is now expected that an elaborate plant will be built to accommodate vessels of large size, if the *Assistance* proves to be all right in actual sea trials. The success of the plating stage of the process is now assured, and all that is needed to demonstrate the success of the process as a whole is a test in actual service, to see if the coating has the permanency which there is every reason to believe it possesses."

Explosions of Steam Pipes.

THE recent frequency of explosions of steam pipes on ships carrying high boiler pressure, which has increased largely since the adoption of triple and quadruple expansion engines, has attracted the attention of marine engineers, who are endeavoring to devise methods whereby these explosions can be prevented, and also, in cases where such explosions seem unavoidable, to prevent the loss of life, and injury to persons, which are now inevitable as the result of such accidents. To this end, Herr H. Gurlt, ex-privy councillor of the German admiralty, in a paper read before Verein Deutscher Maschinen-Ingenieure, April 24, of last year, advocates certain changes in the construction of ships which have met with great favor from marine engineers, and which have been republished in pamphlet form for general circulation. We are informed that this paper is about to be translated into English and Italian, and that it is to be circulated widely among steam-ship owners and the officials of the great navies of the world in the interests of humanity.

Among the changes proposed, the following are the more important, and, though easily executed in building new ships, some of these arrangements cannot be as easily made in floating ships, as additions to their present construction and outfit;—for example, the safety-casing of the steam pipes, which is one of the most important improvements upon present construction advocated. But, under all circumstances, Herr Gurlt regards it as indispensable to make safety-doors and stairs in steamers now having imperfect and dangerous communications between the engine-room and stokeholes and the upper deck, this being a common fault in steamers already afloat, but one which will probably be avoided in future design and construction. In any ship so built it is asserted that no man so unfortunate as to be in the engine-room or stokehole would be able to save his life in case of a heavy escape of steam in the latter. Other safety measures are proposed, one of which is arrangements for automatically stopping the flow of steam into or out of any bursted steam pipe.

In this department for January a statement was made of the breakdowns of steam machinery, from which the proportion of bursted steam pipes for twenty months, beginning with January, 1893, does not seem to be large, relatively to the accidents of other kinds. However,

accidents of this kind are yet too frequent; and, if pipes cannot be made strong enough to withstand the pressures of the strains to which they are subjected on ships, the measures proposed to protect life and limb in case of explosion ought to meet the favor with which they appear to have been regarded.

Steam Life-boats.

THE use of steam propelled life-boats is constantly increasing. *The Engineer* (London, January 18th) describes and illustrates a boat of this kind which appears to be a model of its kind. The machinery is an especially interesting feature. It is of Graham's patent metallic top, two centrifugal pumps, one on each side of the boat are directed by an inclined direct-acting, compound engine worked by steam of one hundred and fifty pounds pressure, which pump is fitted with two outlets, one at the rear and the other at the stern. The outlet at the stern are also fitted to discharge in an athwartship direction which enables th boat to be turned without a rudder and very rapidly. The boat is thus enabled to keep away from a dangerous position much more effectively than were a rudder alone relied upon. For the purpose the entire weight of the machinery is ten pounds. It is quite doubtful whether any other system of propulsion of equal power could have been made with so little weight.

"As to the manœuvring trials of *The City of Glasgow*, which is the name of this boat, one jet going astern enables the boat to turn a complete circle without a rudder in five minutes, five seconds, with a wind force of six. It took one minute twenty-six seconds to turn the boat with the rudder and with both jets driven right ahead and going at full speed. A number of the directors of the Royal Life-boat Institution were present at this test and it is stated that all were satisfied with the great utility of the vessel and the ease with which it could be handled.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

†28457. The Collapse of China at Sea. S. Eardley-Wilmot (F R-Jan.) 5500 w.

*28583. The Rule of the Road at Sea. Abstracts of Speeches by the Lord Mayor of Liverpool, T. Gibson Bowles, and W. H. Colquitt. (F'y-Jan. 11.) 1500 w.

*28617. The Port of London. Editorial (E-Jan. 11.) 1700 w.

*28625. Electricity on Shipboard (E R L-Jan. 11.) 1600 w.

*28639. Specifications for Building a Steam Vessel Suitable for River Navigation. Ill. Anon. (M W-Jan. 11.) 2000 w.

28669. The Electroplating of the Hulls of Iron Ships. Ill. (Sc A-Jan. 26.) 900 w.

*28724. Steam Lifeboats. Ill. (E-Jan. 18.) 1500 w.

*28734. The Midship Section of H. M. S. Magnificent and the Influence of Bilge Keels. Ill. (Eng L-Jan. 18.) 1600 w.

28808. The Electrical Equipment of the "Priscilla." Ill. (E R N Y-Jan. 30.) 1700 w.

28916. An Alluring Proposition—Protection for Farmers and Shipping—D. Lubin's Theory. (Sea-Jan. 31.) 1700 w.

*28968. James Watt and Ocean Navigation. (Abstract) Professor Elgar (E-Jan. 25.) 4800 w.

*28970. The French Battleships Magenta and Hoche. Ill. (Eng L-Jan. 25.) 1000 w.

*29050. Repairing a Broken Valve Chest. Ill. Harold P. Norton (From the Jour. of Amer. Soc. of Naval Eng.) (P Eng-Jan. 25.) 1000 w.

29088. The Loss of the "Elbe." Editorial (E N-Feb. 7.) 1700 w.

Serials.

16636. Marine Engine Design (M W-Began Oct. 6, 1893—19 parts to date—30 cts. each).

26091. Some Points in Modern Marine Engine Practice (I & I-Began Oct. 12—Ended Jan. 4—13 parts—30 cts. each).

27378. Water-Tube Boilers and Their Application to War Vessels. Ill. J. Nastoupil (A E R J-Began Dec.—Ended Feb.—3 parts—30 cts. each).

27521. The Shipbuilding and Engineering Works on the River Clyde. James Deas (E Rev-Began Nov.—3 parts to date—30 cts. each).

28356. Navigable Diving Vessels. Sidney H. Hollands (P Eng-Began Dec. 28—2 parts to date—30 cts. each).

28471. Brooklyn's Original Source of Water Supply. Peter Milne (F W-Began Jan. 12—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

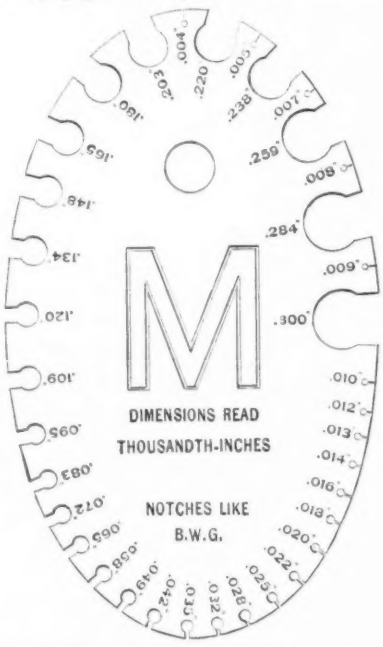
MECHANICAL ENGINEERING

New Design for Wire-Gage.

IN this department for February we reviewed Mr. Oberlin Smith's protest against the absurdities of the government wire-gage, and against wire-gages in general, as hitherto devised to meet some arbitrary and irrational standard. Evidently Mr. Smith does not belong to that class who tear down but are unable to rebuild. He has a new design for a wire-gage to offer, based upon the rational division of that unit of measure most widely used by English, speaking nations—the standard inch. In *The Iron Age* (Jan. 24) he proposes the form shown in the engraving, and states valid reasons for its adoption.

Mr. Smith thinks it very desirable that such a gage should be of some distinctive shape which will not be confounded with any of the old gages, thus preventing mistakes. As there are no wire-gages of elliptical form, he therefore proposes that form, and adds that among other advantages are general beauty of contour and convenience for the pocket. This scheme was recently proposed by Mr. Smith before a joint committee of the American Railway Master Mechanics' Association and the American Society of Mechanical Engineers; he states that it "was unanimously, though unofficially, approved by all the members thereof. It was decided by this committee that a desirable method of marking the notches in such a gage was as shown in the sketch, —*viz.*, by the three figures expressing the decimal of thousandths of inches, with a very definitely marked decimal point to the left of the same, and with the usual double 'inch mark' above and to the right. This uniform use of three figures will tend to prevent mistakes in speaking of the sizes in question, which would not be the case if final ciphers were omitted and certain measurements were allowed to be expressed in tenths or hundredths by the use of one or two figures respectively. In such case, were a measurement, for instance, twenty-one hundredths, it would very likely be spoken of simply as 'twenty one thick' or 'twenty-one gage,' in which contingency it could, of course, not be known whether twenty-one thousandths was intended. By the uniform system mentioned, however, such a measurement would, of course, be known as 'two-hundred-and-ten' rather than 'twenty-one.'"

If desired, it would be easy to construct such a gage to four places of decimals in-



Design for a Proposed New Gauge.—(Full Size).

stead of three, but this is regarded as a rare requirement. For a name the letter M (Roman symbol for one thousand) stamped on the middle of the plate is suggested, as entirely distinctive from the names now in use, and from this the title M-gage naturally follows.

"In general, it may be said that the committee above referred to, as well as

various other would-be reformers who have taken an interest in this question, have not publicly committed themselves to the advocacy of a national legal gage of this sort. They think that such a tool is needed in the present emergency, and that its use is only in the line of carrying out the system of measuring that they are already doing with the ordinary micrometer gage. These gentlemen are, as far as I know, perfectly willing to consider in future an international gage for the whole civilized world, which may or may not be founded upon the English inch, or the French millimeter, or something else not yet worked out. It is a fact, however, that some practical reform must begin pretty soon, and the suggestions herein made are offered simply for what they are worth, with the hope that some useful points, at any rate, may be included therein."

Mr. Smith offers to assign any right he may have as a designer, should this gage be adopted by a joint committee of the principal national engineering societies, and should they think there would be any advantage in obtaining a design patent for it.

"Referring more in detail to the picture, there is shown therein, drawn to the real size, a gage embodying somewhat the above ideas, and one, moreover, which would be notched and graduated to any desired set of sizes without upsetting the system involved. It would (wherever it happened to have any sizes in common with it) agree absolutely with the Whitworth gage—and with common sense. The particular graduations shown in this case do not fulfil my ideal, as the sizes do not run in a proper series. It is made as it is merely to show how the ordinary B. W. G. gage would look with the proposed new system applied to it, the notches being a copy of the same from 'No. 1' to 'No. 36.' This might be convenient for some of the iron men, whose sizes are pretty well fixed, and the old fogies could have the numbers of the B. W. G. stamped upon the other side of it, if they so desired. It would thus serve as a translator, so to speak, from the old system to the new." This point seems well taken.

Emery Wheels.

THE use of abrasion as a factor in fine mechanical fitting, through the agency of emery wheels and ingenious machines adapted to apply these wheels to various purposes in mechanical construction, has now become a permanent feature of machine-shop practice. It is not likely that, when emery wheels were first invented, their inventors even dreamed of the value of the new resource they were supplying to mechanical engineering; yet to-day there is no other means whereby cylindrical and other forms can be obtained so accurately, and, after the action of a lathe, so expeditiously as by emery grinding. This method, at first confined to burning castings and smoothing rough surfaces, now finds a use in the most refined fitting of journals, piston-rods, interior cylinder surfaces, etc., and emery grinding has come to be an indispensable supplement to the action of other machine tools. In *Industries and Iron* Mr. W. Samuel Worsam, C. E., has recently given information regarding the composition of emery wheels, much of which has not hitherto been familiar even to those who have most extensively used them.

The first materials used for conglomerating emery into solid wheels were glue and treacle, and the wheels so made were of a very inferior quality. The next step in advance was made by the celebrated American inventor, Goodyear, who used india-rubber and gutta-percha as cementing materials These wheels heated under friction, the cementing material softened by the heat, and the wheels glazed quickly. To restore the cutting quality they had to be turned off after the cement at the perimeter had been heated sufficiently to carbonize it. When the chemists Jacques and Fanshaw adapted a material discovered by Walton (inventor of the well-known material, "Lincrusta Walton") to the manufacture of emery wheels, the rapid rise of grinding, as a machine process, into general favor fairly began. Oxidized linseed oil, mixed with about half its weight of shellac, asphalt, or bitumen, was the material employed by these inventors, and the wheels made in this way far exceeded in

quality any that had preceded them. These wheels were shown at the London International Exhibition in 1862, and attracted much attention there, and, though many other emery wheels, notably the Tanite, Norton, Bateman, Luke and Spencer, Diamond, Sterling, Sundale, Naxon, Detroit, Celluloid, etc., have since been introduced, the wheels of Jacques and Fanshaw, now called the "Sterne" after their manufacturer, still retain a goodly share of favor. Emery wheels are now made from $\frac{1}{16}$ in. to 8 in. in thickness, and from $\frac{3}{4}$ in. to 40 in. in diameter. "Their economy in working is marvellous; a man can drive a file about 60 ft. a minute over a flat metallic surface, but it is soon worn out; whereas a well-made emery wheel will work up a surface of 5,000 ft., and last a considerable time without appreciable wear. It has been proved repeatedly by practical men, after careful experiments and observation, that to remove a pound weight of iron with a file costs about 2s. 6d., whilst the same amount of work can be done by a good wheel at the moderate expenditure of 4d.; and, further, the latter will execute the work in about one-eighth less time than the file. An emery wheel will frequently cut away twelve times its own weight of metal before becoming useless. As an instance of the great cutting power of consolidated emery may be mentioned the fact that a disc 12 in. in diameter and only $\frac{1}{16}$ in. thick will cut slits 4 in. long in tough cast-steel $\frac{1}{2}$ in. thick."

"Compound emery wheels are available for many particular operations, and for dry grinding of hot or chilled cast-iron rolls. It is difficult to enumerate the varieties of work for which these wheels, in their different grades, are available; there is a constantly increasing demand for them, and not only have they become a necessity when once adopted, but new fields of application are daily opening to them."

"They are of the greatest service for all kinds of engineer's tool-grinding, saw-sharpening, fettling and trimming castings, grinding chilled rolls, locomotive slot links, plane irons, knives, india-rubber rolls for wringing, printing, and other machines, brushes, eyes, female mandrels straight and spiral rimers, milling cutters, taps, circular knives and slitters, lathe centers, twist drills, etc. Not the least call on these wheels is that for sharpening machine saws. A well made and mounted emery disc, properly worked and running from 6 to 9 hours a day, will last some 3 months, and will gullet, sharpen, and top, on the average, two hundred deal frame saws each day of 9 hours. It is found in practice that the action of the disc on the teeth hardens the cutting points, with the result that the saws last longer when machine- than when hand-sharpened."

Emery wheels are specially adapted to grinding brass, copper, and other soft metals and alloys, and wheels of emery composition are specially suited for decorticating and grinding rice and other grain, and have been found superior to, and more economic than, the French Burr stones.

Limitations in Patent Suits.

A RECENT decision of the United States Supreme Court delivered by Justice Brown *in re* Campbell v. City of Haverhill is one which may in some cases materially affect proceedings for recovery of damages for infringement of patents. *Scientific American* (Jan. 26) says "this action was brought to recover damages for infringement of the claims of a patent, which infringements were committed between October 10, 1877, and December 20, 1880, and was begun more than 6 years after the last date of infringement. It was an action at law, brought in the United States Circuit Court in the district of Massachusetts. The Massachusetts laws declare that a limitation of 6 years applies to all actions of tort,—that such actions must be begun within 6 years of the time when the acts were committed. The Circuit Court decided that the statute of limitations applied to this case. The Supreme Court upholds the Circuit Court."

The United States Revised Statutes (section 721) provide that "the laws of the several States, except, etc., ... shall be regarded as rules of decision in trials at common law, in the courts of the

United States, in cases where they apply." This section has been repeatedly held to apply to the statutes of limitation of different States. The question, then, came up as to whether this section would apply in cases purely within the jurisdiction of the federal courts, such as a patent case, based entirely on the United States statutes. In the words of the decision it is expressed thus: "It may be well questioned whether there is any sound distinction in principle between cases where the jurisdiction is concurrent and those where it is exclusive in the federal courts. The section itself neither contains nor suggests such a distinction."

The opinion of the court is that it would be an anomaly to establish a class of actions subject to no statute of limitations, and therefore holds that actions for infringement of patents should involve no privileges denied to the plaintiff side in other actions. With reference to the natural query as to why this point has not before been settled, the *Scientific American* explains "that the majority of patent cases are brought for present infringement of a live patent, and ask for an injunction and an accounting. Proverbially, there is little money in an accounting; the injunction is the object principally sought. But, in the case just spoken of, the patent had expired, and damages were sought for infringements committed during its life. Such actions are generally regarded as of little value to any one except the lawyers and masters of referees, and hence are seldom brought."

Thermal Value of Fuels.

THE question of the thermal value of different fuels is treated in a practical and satisfactory manner in an article by Mr. E. P. Reichelm in *American Machinist* (Jan. 10). Taking as a common ground for comparison the theoretical number of heat units in equal weights of various fuels, and deducting the average loss by draft and other wastes, he calculates the cost of the net available heat units according to the average price of the fuels considered, and tabulates the results.

"A ton of coal of 2,000 lbs. contains about 28,000,000 heat units, or 14,000 in each pound. Under ordinary conditions the loss by draft, radiation, and the heating of surplus space is estimated at 80 per cent., or 22,400,000 heat units per ton. This leaves available for actual work 5,600,000 heat units, and, assuming the cost per ton of coal to be $4.00, the cost of 1,000,000 heat units would be 73 cents.

"Petroleum theoretically contains 21,000 heat units per pound, or 136,500 to a gallon of 6½ lbs. A fair and moderate deduction for waste is about 70 per cent., which would leave, say, 41,000 heat units as applied to work, from each gallon consumed. At the cost of 3 cents per gallon, 1,000,000 heat units would therefore cost 73 cents, exclusive of the cost of compressed air. This estimate is based upon larger forge fires and ovens, and the loss is greater in heating smaller spaces by reason of the necessity for disproportionately large combustion chambers.

"By the use of gas in properly-constructed furnaces, which secures perfect combustion by the intimate combination of gas with air in exactly proper proportions, the loss of heat is practically limited to that proportion which necessarily escapes with the products of combustion from the vent-holes or from the entrance to heating chambers which contain but very little surplus space. This loss is practically the same for any kind of gas, above the grade of producer gas, if properly used, and amounts to about 25 per cent. of the heat generated."

The table represents the comparative thermal value of fuels as used in forge fires, drop forging, annealing ovens, brass and copper melting, case hardening, muffle furnaces, and kilns. The accuracy of the table has been verified by records of actual daily work, some of which are presented by Mr. Reichhelm, and which correspond with the tabulated statement very closely. The article concludes with the statement that the fuel of the near future will be gaseous. "That no fuel should be used for any mechanical heating operation except it be first converted into gas must necessarily become an axiom in mechanics

within a very few years, and only the first cost of the installation of proper gas-making machinery retards rapid progress in that direction. Considering the wonderful improvements constantly made in the perfection of automatic machinery for every conceivable purpose, it seems strange that the generation and systematic application of heat should not have received that attention which its importance in nearly every line of productive industry undoubtedly deserves."

The College Engineer.

A WRITER in *American Machinist*, who signs his article F. P., illustrates how a certain class of graduates from technical institutions (admitted, however, to be a minority) are injuring the engineering profession by bringing discredit, not only upon the schools from which they have graduated, but upon the really able and competent majority of their fellow-graduates. He states that a superintendent of a mechanical establishment lately said, in conversation, that the "technical men" he had employed to work for him were always going to revolutionize matters by doing such "big things," as he termed it, and that they were always taking steps which they assumed (but never quite knew for sure) to be right, and would continually bring out their "theory" in defence of the steps taken; and, continuing in this strain, he said "that he did not think that the college *professors* knew it all, either."

Regarding this superintendent as having been unfortunate in his selection of technical men, F. P. inquired their names, and recognized among them that of a young man with whom he had formerly been well acquainted,—a typical example of the minority above spoken of. "Having had frequent opportunities to observe this young man's work in college, I noted that he seldom did any original work, always trying to imitate the methods found in books or the work of his classmates, without having any clear idea as to just why he took a particular step in the solution of a problem or the demonstration of a mathematical formula. In the laboratory and testing work he usually followed closely the rules set down by his instructors, filling out reports according to precept, and his whole aim appeared to be to get a good percentage mark on his term record, without appearing to care whether or not he knew anything about what he had been doing. This class of students usually succeed 'by hook or by crook' in securing good class records, and at the completion of their college course are 'turned loose' on the world as 'engineers of good standing,' and are falsely rated on a par with the—I am happy to say—larger percentage of graduates who do know something about their profession. I am loath to say that the systems in vogue for the graduation of engineering students are sorely lacking in their ability to detect these students who have a lack of practical originality, and of debarring them from entering a profession for which they are so little fitted."

Herein is a fine thrust at the system of examination now in vogue in most of our institutions of learning. A system of education should, and does, for the most part, fit a man for some useful work. If it be a special system, it should fit men for special work. At the end of the course, and at stated periods during the course, practical tests of fitness for such special work should be applied. If a man has taken a course in mechanical engineering, he should, so far as a school can make him, come out a mechanical engineer. That will be what the degree conferred upon him at his graduation indicates. Why not test his quality by actual work in the drawing-room that shall call for the exercise of all the qualifications of a mechanical engineer, instead of counting up his marks in a record-book? Questions may be answered correctly in the class-room without anything like a comprehensive understanding of the full meaning and practical applications of the answer. And, if lessons are conned solely with a view to pass muster in the recitation-room, as is generally the case with the minority under consideration, the answers for which credits are awarded are very often well forgotten long before graduation day. We maintain that a task or tasks

could be set in the drawing-room to a candidate for the degree of M E. that would certainly and accurately measure his fitness to receive that honor.

Condition of Uninsured Boilers.

WITH reference to the condition of uninsured boilers, the *Boston Journal of Commerce* quotes the report of Thomas Hawley, State inspector of boilers for Massachusetts. After stating that in 405 boilers inspected 842 defects were discovered, 169 of which were dangerous, and that 88 boilers were not properly inspected, the inspector repeats an observation made in his last year's report, to the effect that uninsured boilers are neither properly inspected or adequately cared for. "It is not uncommon experience to find no one about a steam plant who can tell anything whatever about the condition of the boiler, or with any knowledge of when the boiler has been inspected. It frequently happens that boilers are reported as having been inspected, but, upon investigation, it appears that this inspection, so-called, was merely the opening of the boiler to see if there was any dirt in it. In very many instances the inspection was reported made by some machinist or boiler-maker in the town, and consisted simply in looking for leaks, and did not take into account the pressure at which the boiler was to run, its age, and how much it had deteriorated. So long as leaks did not appear, the owner was satisfied to have it continue in service. Leaks were made the standard of inspection, and the absence of a leak was held to signify that the boiler was safe.

"Boilers insured in boiler-insurance companies are provided with regular inspection; but the majority of those not so insured are without proper inspection, and whether they are safe or not is a matter about which their owners have very little knowledge. This, it seems to me, is pretty clearly shown by the defects found in boilers inspected, some of which have since been repaired at my suggestion; but many boilers are still in use, and no apparent attention given to making them safer." A similar state of things exist in other States.

Relative Tests of Cast Iron.

A COMMITTEE was appointed some time ago by the American Society of Mechanical Engineers to investigate the question of uniform standards in test specimens and methods of testing materials. Mr. W. J. Keep, a member of that committee, has presented to the society a monograph on tests of cast iron, which is quoted, with the discussion by other members, in the *Iron Age*. Mr. Keep gives the results, graphically, of a large number of tests, made with the purpose of providing a means for determining the physical quality of a casting of any size or shape from the test record of any test piece which it may be thought best to use. "Relative tests" are defined to be such as are applicable to any case. In such tests any size of test piece might be selected; and, having made one test record, every other record by the same method is so much greater or less than the original, which is regarded as standard. In the series of tests referred to it was decided to make enough test bars of definite composition and of such sizes as would establish experimentally the relationship between the physical quality of test bars of any size and form that had ever been used for cast iron. "We could then," Mr. Keep explains, "make rules and construct charts by which a test record of one size of test bar could be turned into the record of a test bar of another size. We could reconstruct formulæ which might be found to be incorrect. We could show by diagrams the influence of a change in composition on any size of casting." In the discussion of the paper considerable difference of opinion was developed as to the universal applicability of the shrinkage charts constructed from the experiments, the data for strength not having been worked out.

"MACHINE Shop Milling Practice," by Horace L. Arnold, serially published in *American Machinist* will, we hope, be republished in book form. It ought to take a permanent place in mechanical engineering literature.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

28393. Drilling Machines for Cylindrical Boiler Shells. Ill. Samuel Dixon, Manchester (Ir Age-Jan. 10.) 4000 w.

28521. Chucks and Chucking as Applied to Pattern-Making. John M. Richardson (A M-Jan. 17.) 2200 w.

28522. An Instructive Job of Broaching. Horace L. Arnold (A M-Jan. 17.) 3000 w.

28678. Pattern for a Bonnet. George Guntz (A M-Jan. 24.) 1200 w.

*28849. A New Drawing Instrument. Ill. Harvey D. Williams (S J E-Jan.) 1300 w.

28876. The Standard Castor and Wheel Company's Work. Ill. John Randol (A M-Jan. 31) 2800 w.

28877. Hints on Designing—An Inside Facing Tool. Ill. William H. Stedman (A M-Jan. 31.) 450 w.

*28918. Steam Hammer Tools. Ill. James F. Hobart (N C B-Feb.) 600 w.

28925. Selecting Change Gears for Screw Cutting. W. L. Cheney (M A-Feb.) 2200 w.

29075. The Richards Molding Machine. Ill. (Ir Age-Feb. 7.) 2000 w.

29114. Shop Tools and Jigs—Heading Small Bolts, etc. Ill. James F. Hobart (A M-Feb. 7.) 3000 w.

Steam Engineering.

28478. The Condition of Uninsured Boilers. Anon. (B J C-Jan. 12.) 2500 w.

28520. Increasing Use of Traction Engines. Ill. (Sc A S-Jan. 20.) 200 w.

28565. Steam Engine Rivals.—Will It Be Superseded by Any Other Power? (B J C-Jan. 19.) 2300 w.

*28571. Intermittent Firing and the Prevention of Smoke. (Abstract.) R. Le Neve Foster (I C T-Jan. 11.) 1800 w.

28578. Proposed Legislation on Boiler Inspection in Michigan. (S V-Jan. 15.) 3300 w.

*28690. Some Causes for Bad Workmen and Bad Work. A Chicago Journeyman Steamfitter (D E-Jan.) 3000 w.

*28736. Liquid Fuel. Editorial (Eng L-Jan. 18.) 1200 w.

*28746. The Temperature Cycle in a Cylinder Wall. E. Thomas Adams, in Cassier's Magazine (P Eng-Jan. 18.) 1700 w.

†28790. Boiler Explosions. Ill. John L. Gill, Jr., with Discussion (P E C P-Jan.) 3500 w.

*28845. Pressure and Impulse in Motive Engines—A Look into the Future. John Richards (I S F-Feb.) 4800 w.

*28848. The Comparison of Simple and Compound Engine Diagrams. John H. Barr (S J E-Jan.) 3300 w.

28881. Fly-Wheel Failures—An Expert Reviews Some of the Causes (B J C-Feb. 2.) 2000 w.

29060. Testing of Steam Boilers. Ill. R. C. Carpenter, with Discussion (H & V-Feb. 1.) 7500 w.

29061. Heating and Drying by the Use of Exhaust Steam and Live Steam Reduced to Low Pressure, Either Separately or in Combination. Alfred A. Hunting, with Discussion (H & V-Feb. 1.) 1500 w.

29116. Cylinder Condensation. W. H. Booth (A M-Feb. 7.) 1100 w.

29143. A Fatal Boiler Explosion—Mashapoag Pond, Providence, R. I. (B J C-Feb. 9.) 1100 w.

Miscellany.

28379. The Relative Values of Different Fuels. E. P. Reichhelm (A E-Jan. 10.) 1500 w.

28380. Air-Pump Capacity. Ill. Charles M. Jones (A M-Jan. 10.) 1700 w.

*28383. Review of Book by M. Witz on Gas and Petroleum Engines. (J G L-Jan. 1.) 2400 w.

28404. The American Gas Furnace Company's Gas Plant and Furnaces. Ill. (Sc A-Jan. 12.) 1600 w.

28409. Portland Cement Works of the Whitaker Cement Company. Ill. (E N-Jan. 10.) 1800 w.

28410. A New Current Meter and a New Method of Rating Current Meters. W. G. Price (E N-Jan. 10.) 1800 w.

*28460. Mechanical Engineering. Editoria Review of 1894 (Eng L-Jan. 4.) 4000 w.

28479. Fallacies in Engineering—Why Some New "Inventions" Failed (B J C-Jan. 12.) 2500 w.

*28491. Emery Wheels. W. Samuel Worssam (I & I-Jan. 4.) 3000 w.

28540. A Final Decision on a Mechanical Filtration Patent (E N-Jan. 17.) 1200 w.

28549. Future Situs of American Manufacture. J. C. Ransom (T-Jan. 15.) 2700 w.

28579. The Gas Engine. Dugald Clerk (S V-Jan. 15.) 2000 w.

28655. Design for a Proposed New Gauge. Ill. Oberlin Smith (Ir Age-Jan. 24.) 1200 w.

*28665. Improved Gas Furnaces. Ill. (M-Jan. 15.) 1600 w.

28672. The Friedeberg Apparatus for Burning Coal Dust. Ill. (Sc A S-Jan. 26.) 1400 w.

28676. A New Screw Thread. Ill. A. M. Powell, with Letter (A M-Jan. 24.) 2400 w.

We supply copies of these articles. See Introductory

*28689. Bossing a Job. A. Dept. (D E-Jan.) 1100 w.

28750. A Stone-Cutting, Elevating, Screening, Storage and Conveying Plant. Ill. (E R-Jan. 26.) 700 w.

*28769. The Manufacture of Wood Pulp. Anon. (C T J-Jan. 19.) 2700 w.

28800. Report of the National Association of Manufacturers Organized at Cincinnati (A S-Jan. 26.) 7000 w.

28833. The Statutes of Limitations in Patent Suits (Sc A-Jan. 26.) 600 w.

†28835. A New Form of Water Oven and Still. Ill. Lewis W. Hoffman and Robert W. Hochstetter (J A C S-Feb.) 700 w.

*28850. Test of Sibley Turbines. T. T. Hubbard and G. W. Collins (S J E-Jan.) 1100 w.

†28851. Mechanism of the Pocket Watch. Ill. H. E. Duncan (J F I-Feb) 6200 w.

†28865. New Weapons of the United States Army. Ill. Victor Louis Mason (C M-Feb.) 8000 w.

28888. Rustless Coatings for Iron and Steel. Abstract of Second Paper of M. P. Wood (E N-Jan. 31.) 3800 w.

28928. The Use of Compressed Air. Charles A Bennett (E M J-Feb. 2.) 1700 w.

28993. The National Convention of Manufacturers in Cincinnati—Proceedings (T-Feb. 1.) 6500 w.

29016. Shafting, Pulleys, etc. C. R. Tompkins (A S-Feb. 2.) 1200 w.

*29043. Mechanical Engineering in 1894 (E Rev-Jan. 21.) 1300 w.

29063. The Quast Gas and Gasoline Engine. Ill. Charles Quast (E R N Y-Feb. 6.) 600 w.

29106. A Valuable Graphic Diagram. Ill. P. M. E. (Pr-Feb.) 1500 w.

29113. A Cheap Transverse Testing Machine and Some Results Obtained by It. William Kent (A M-Feb. 7.) 1500 w.

29115. A Cheap Planimeter, No. 2. Ill. Frank E. Ward (A M-Feb. 7.) 400 w.

29118. The College Engineer. F. P. (A M-Feb. 7.) 1200 w.

†29139. The Greatest of All Rubber Factories. A. M. Stickney (I R W-Feb. 10.) 2000 w.

†29140. Why a Pneumatic Tire is Fast. Sterling Elliott (I R W-Feb. 10.) 3000 w.

29141. An Historical Survey of the Science of Mechanics. R. S. Woodward (Sc-Feb. 8.) 6800 w.

Serials.

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7, 1893—18 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1, 1893—30 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March, 1894—12 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Radinger (E M-Began April—10 parts to date—30 cts. each).

24338. The Gas Engine. Ill. Anon. (P A-Began Aug. 15—7 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L-Began Aug. 31—12 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Schefller, Jr. (M A-Began Oct.—5 parts to date—15 cts. each).

25611. Calculation of a Compressed Air Transmission When the Subsidiary Losses of Energy Are Taken into Account—From Professor Unwin's "Development and Transmission of Power" (E M-Began Oct —3 parts to date—30 cts. each).

27423. Repairing Steam Engines. Ill. (S M-Began Dec. 1—5 parts to date—15 cts. each).

27574. The Stresses on Hemp Ropes and Leather Belts Used for Driving. M. Fauquier (P Eng-Began Nov. 30—3 parts to date—30 cts. each).

27594. Erection of a Corliss Engine. Ill. A. S. Mann (Pr-Began Dec.—3 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M W-Began Dec. 7—3 parts to date—30 cts. each).

27635. The Principles and Practice of Hydro-Extraction. H. B. Ransom (M W-Began Oct. 7—Ended Jan. 11—3 parts—30 cts. each).

27638. Rope Tramways. (I E-Began Nov. 10—2 parts to date—45 cts. each).

27697. Conditions Which Determine the Choice of a Steam-Engine. J. W. Hall (I C T-Began Dec. 7—Ended Jan. 11—4 parts—30 cts each).

28021. Attachments and Conveniences for Universal Milling Machines. Ill. Warren E. Willis (A M-Began Dec. 27—2 parts to date—15 cts. each).

28181. The Use of Compressed Air. Anon. (P A-Began Jan. 1—Ended Jan. 15—2 parts—15 cts. each).

28391. Making 28-Inch Ball Joint Pipe. Ill. (Ir Age-Began Jan. 10—Ended Jan. 17—2 parts—15 cts. each).

28400. The Building of a Locomotive Boiler. W. D. Wansbrough (M W-Began Jan. 4—2 parts to date—30 cts. each).

28401. Boiler Trials. W. H. Wakeman (M W-Began Jan. 4—2 parts to date—30 cts. each.

28745. The Trials of Oil Engines at Cambridge (P Eng-Began Jan. 18—1 part to date—30 cts).

28926. Recollections of the Use of the Steam Engine Indicator. F. F. Hemenway (M A—Began Feb.—1 part to date—15 cts).

28967. On Results of Evaporative Tests on Land Boilers. George Carruthers Thomson (E Began Jan. 25—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MINING & METALLURGY

Improvements in Matte Smelting.

SOME rather revolutionary statements about the pyritic or iron-matte smelting processes are presented by Mr. Herbert Lang in a long and interesting article published in the *Mining and Scientific Press*. The author distinguishes two divisions of modern pyritic smelting. One, the Austin process, is characterized by the rapid combustion or fusion of the charge; the other, the gradual reduction method, by slow heating and subsequent fusion of the matte-forming constituents. In the former special arrangements are made for feeding the combustible ores directly into the zone of fusion; while in the latter the furnace is fed in the ordinary way, the ore mixture being fed at the top in layers alternating with the fuel. Mr. Lang inclines strongly to the gradual reduction process, and his paper is mainly devoted to its description. The German system of plain matting, for the extraction of gold, silver, and copper, the slagging of the earthy substances, the reduction of metallic oxids and the preservation of most of the sulphur and the arsenic in the matte, but without much concentration of the latter, and with but slight utilization of the sulphur, etc., as fuel (which are the essential features of recent American practice), is not discussed.

After considering the known and probable reactions between all the elements present, and giving a table showing what occurs in pyritic smelting as distinguished from the old plain matting, the author proceeds to practical details of working and notes,—among others, the following points, some of which are still open to argument. The ores suitable for pyritic smelting are the oxidizable minerals, such as are commonly roasted in other processes, belonging to the class of sulphids, arsenids, and antimonids, embracing pyrite, pyrrhotite, chalcopyrite, blende, mispickel, and probably galena, to which may be added in the course of experience the remaining minerals of these classes; that is, anything which by melting down produces matte or speiss. These are the refractory substances of other processes. For the present the method is limited to gold- and silver-bearing pyrite, and in less degree to ores containing blende and chalcopyrite. Contrary to the practice in lead and copper smelting, the absorbing product for gathering the precious metals (in this case the matte) should be formed in the smallest amount that will be effective; and Mr. Lang claims that in his experience even so small a proportion as one-fortieth of the charge has done good service, while he does not consider the work satisfactory that fails in putting at least ten tons into one, and, with more favorable conditions, a twenty to one ratio should be practicable.

Mr. Austin, who is properly characterized by the author as the real inventor of pyritic smelting, has maintained that enough heat is given out by the internal combustion of a fairly favorable charge to smelt it; but Mr. Lang asserts that the result of the vast deal of experimenting and practical smelting within five years in pyritic furnaces teaches us not to smelt without carbon fuel, but to smelt with a smaller proportion than any other smelting process has ever used or can use. It needs but 4 or 5 per cent. of coke, supplemented with the hot blast, to fuse charges of ordinary difficulty, containing 10 to 20 per cent. of sulphur. Mr. Lang thinks that the furnace managers who have given up the hot blast and condemn its use entirely are in error. He advocates utilizing the waste heat of the slag to heat the blast, instead of special stoves.

As to the speed and capacity of pyritic furnaces and the consequent saving in time and labor, Mr. Lang takes extreme ground in favor of slow work, and says that the essential thing is not to crowd a great deal of material through, but to do good work on what one has. He believes in large furnaces working very slowly, at the same

daily capacity as smaller ones fast driven, and urges that the additional cost of plant cuts no figure, while the labor of feeding and tapping are about the same. There should be no heat to spare, the slag being only hot enough to secure separation from the matte, and hence Mr. Lang believes that water jackets are unnecessary, and that thick brick or stone stacks are better, as retaining the heat and not liable to corrosion at the low temperature. "In order to continue slow running with attendant high concentration and cooling of the hearth, it is necessary to return much matte to the charge, the action of which is to heat up the crucible and render tapping easy, while its further combustion, which takes place to quite an extent each time it goes through, effects a desirable enrichment." It is questionable whether this does not involve loss of precious metal in the slag and by volatilization, as has occurred in recharging lead bullion in districts where the lead ore supply was scant; but Mr. Lang is convinced that the regular feeding of matte as part of the charge will be a recognized feature of the process, and to save heat he has devised means for elevating and feeding the matte in a molten condition, in a thin stream which breaks up into particles that are scattered over the surface of the charge.

The author advocates furnaces with vertical sides, and not inverted frustra of cones or boshes and tapered hearths, the idea being to get a greater diffusion of uncombined oxygen from the tuyeres to the level where the heated sulphids are ready for combustion. The furnaces should be run with cold tops. They should be low, and the author goes so far as to say that "a greater depth of charge than four feet, or possibly five, is a grave mistake."

The losses, as in all smelting, are mainly threefold: (1) in slag, (2) in flue dust, and (3) by volatilization. The first two exist to the same extent as in the German system and in lead smelting. Regarding volatilization losses furnacemen are somewhat in the dark, but the highest losses occur when "fire tops" are permitted. Silver, as usual, volatilizes to a much greater extent than gold, as would be expected from knowledge of the behavior of the two metals. In one campaign of three weeks Mr. Lang found the combined slag and volatilization losses to reach 15 per cent.,—a result he attributes to over much experimenting. In another run of 1800 tons of ore his losses footed up 11 per cent. of the silver, part of which was due to experimental bessemerizing of some of the matte. These intolerable losses were experienced under circumstances which suggested the causes and remedies, so that later the savings reached 95, 97, and 102 per cent. of the assay content in different campaigns. The last result, unexpected but not unprecedented, he remarks, serves to emphasize the inaccuracies of assay methods. Bessemerizing is stated to be inapplicable to most argentiferous mattes.

Mr. Lang's general conclusions are that pyritic smelting to-day lacks nothing in conception or in principle or in scope of usefulness, but needs chiefly the effort of scientific adepts and of skilled operatives, the one to make known its underlying principles, the other to carry on its practice; that in looking over its wide field the most profitable immediate application is in the treatment of difficult ores in isolated districts, in fields altogether new, or in supplanting in older localities less effective processes; and that it will supersede (within its range of ores) in the not distant future (1) those processes which fail to yield a high percentage of precious metal, (2) those which, like amalgamation, afford no valuable by-products, and (3) those which, like lixiviation, require costly preliminary experimentation and give an uncertain yield.

Soldering Aluminum.

ONE of the objections hitherto urged against the more widespread use of aluminum as a substitute for other metals has been that it could not be effectually soldered, although for some time inventors had given their time and attention to the matter. *Invention* states that no less than eight English patents for soldering aluminum were taken out in 1893, with probably as many more for the year just closed. Already two or three of these processes,

our contemporary is informed, have passed the experimental stage, and are now being used. A difficulty met is that aluminum is very easily oxidized, at least superficially, so that, no matter how brightly polished, it rapidly becomes covered with a thin film of oxid, the latter, however, protecting the metal against further oxidation. The great secret is to make sure that the pieces to be soldered are entirely free from any oxid; otherwise, it is said, it is impossible to join them strongly together.

One process described in *Invention* includes not only a special solder (an alloy of several metals), but also a suitable furnace for keeping the metal at the temperature at which the operation should take place, and also an arrangement of brushes and other tools, with which the surfaces may be scraped and cleaned, so as to get the solder well into the metal. Small pieces can be soldered with the blowpipe, but for large ones some such special furnace is claimed to be advantageous. Good results are reported.

The annual output of aluminum has increased from about fifty tons in 1890 to about two thousand tons in 1893, according to *Invention*, with a large drop in price. It is not now manufactured in England, the companies formerly using chemical processes of production not being able to compete with the electric plants of the United States, Switzerland, and France. A company (the British Aluminum Co.) has been formed, however, for the manufacture of aluminum in England by the processes successfully used in the Swiss and French works. Water power will be employed, and the raw material is to be derived from the north of Ireland.

Stone Coal in the Lead Blast Furnace.

SOME results of runs at the Germania lead works, Salt Lake City, in which lump and nut coal was used in admixture with coke or charcoal or both, are communicated to the *Engineering and Mining Journal* by Mr. L. S. Austin. Details are given of experimental runs in which varying proportions of stone coal were thus used in connection with either or both of the other fuels; and the conclusion arrived at by Mr. Austin is that under favorable conditions as to price of coal and kinds of ore he would certainly advocate the use of coal, satisfied that it could be introduced with profit. He considers that, when mixed with coke, it has much the effect of charcoal in promoting the speed of the furnace. The following suggestions are offered: (1) Coal is not to be used in presence of arsenic and copper in quantity. (2) The feeding of coal should be carefully watched to avoid imperfect reduction. (3) Coal may be profitably used only when the difference in price between it and coke is considerable. (4) The total fuel should be at least one to two per cent. more than if coke alone is used.

New Enterprises in Gold Mining.

AN editorial article in the London *Mining Journal*, discussing the present status of gold mining in the investment and speculative market, after alluding to the revival of interest in the industry brought about by the success of certain gold districts and flattering anticipations in others, says that the immediate result of this popularity of gold mining is certain to be an extension of public interest in new ventures. It is, no doubt, an advantage to the vast majority of investors that they can put money into proved undertakings without much risk of losing it; but, as the *Journal* points out, having to pay for this absence of risk in a smaller percentage of dividend, many investors would prefer to strike out in new directions, and take part in enterprises in which the proved results have not as yet advanced shares to a level inconsistent with profitable speculation. It is surprising that the interest in legitimate mining has not been taken advantage of by promoters in floating more new concerns than have lately made their appearance on the London market; and this the *Journal* considers an indication of the more healthy tone of mining speculation, showing that the public is less credulous nowadays—as it well might be in view of the many hard experiences of the past. "In fact, it seems as if the business of the promoter who floats a company with the sole idea of making a profit at the expense

of the shareholders is pretty well played out, or at least the fierce light of criticism which beats upon suspicious undertakings is so efficacious that they are rarely able to survive beyond the preliminary stages of formation." "Investors are quite content to wait before venturing their capital in the working of properties of which the value can at the best be only imperfectly known, and, if the mines prove to fulfil expectations, there will be no lack of capital for carrying out operations upon a sufficiently extensive scale." The reference is here to certain African districts outside the Transvaal, to those of Siam, and more especially to the recent glittering discoveries in West Australia. Some of these latter are undoubtedly rich, but the *Journal* cautions moderation upon the part of newly-formed companies, and impliedly rather disparages the mere "prospects."

While the *Mining Journal* considers the case from the point of view of investors, Mr. T. A. Rickard, writing to the New York *Engineering and Mining Journal*, sounds a timely note of warning to American miners thinking of going to the new West Australia fields, and says that no person should go without purchasing a return ticket, as the journey is a long and expensive one. Mr. Rickard also cites the high prices of provisions, etc., there, and the low wages and scarcity of work—to which is added unusual hardship. He further believes that, "while one or two of the mines are doubtless destined to a future of important productiveness, many of those sold recently in London are wildcats of the wildest kind."

Malleable Castings from Coke Iron.

THE manufacture of malleable iron castings has long been an important branch of the American foundry trade, and is a specialty of large establishments in various localities. *Iron Age* considers the desire to attain in them lightness with strength, avoiding clumsiness and appearance of heaviness, to be due to a recognized national trait. Safety and durability are not lost sight of, but surplus metal is avoided so far as possible. "Until recently," says *Iron Age*, "the peculiar excellence of American malleable castings has been attributed in no small degree to the character of the pig iron used. Lake Superior charcoal iron was considered the ideal material, being smelted from very rich pure ore with the purest of fuels." But the same journal reports that coke pig in mixture with charcoal iron is invading this field, and that the former threatens to absorb the whole trade. Two reasons are given for this revolution: first, the demand for cheaper material; secondly, the effort of coke iron producers to widen the consumption of their product. Our contemporary states that the method adopted by the coke iron producers to satisfy requirements is to analyze every carload of iron destined for malleable castings, so that the consumer knows just what he is getting and can determine the exact treatment needed—and this is another triumph for the chemist in metallurgy. To meet these conditions the producer of charcoal iron must not only sell on even terms, but furnish an analysis of each carload; so the mere fact that the iron is smelted with charcoal will not be accepted as a guarantee of uniformity, or even of superior fitness for the special purpose.

Gold Mining in Ecuador.

ECUADOR is less generally known as a gold-mining country than some of her sister republics of South America, and this renders a recent communication of Mr. O. A. F. Saabye to the *Engineering and Mining Journal* of special interest. While Ecuador is not so rich in the precious metals as some other South American countries, for centuries gold has been profitably mined there, west of the Andes, by Spaniards and natives, many old reservoirs and ditches still remaining in a comparatively good state of preservation to bear testimony to the former workings. But it was only a few years ago, says Mr. Saabye, that it was discovered that a new region in the northwestern part of the country, also among the western spurs of the Andes, contained placer gold. The natural conditions of the country being favorable for hydraulic mining, several mining companies were formed by North American cap-

italists, of which four companies, together holding about 190 square miles, are the most important and are in operation at the present time. These placers are near the Colombian boundary, and about 35 to 40 miles east of the Pacific coast. They are easily accessible and have abundance of water and grade. The auriferous gravel is located at greater or less distances along the streams. Its depth is very variable, running from 4 to 80 feet above bed rock, and nearly always covered with alluvial soil, also of variable thickness. The gold is coarse. As to the richness of the gravel, Mr. Saabye states that the various expert reports, based upon experimental washings, place it at from 25 cents to $2.50 per cubic yard, with a reliable average of 45 to 60 cents. The natives are nearly all full-blooded negroes, and under proper management make good and cheap laborers.

Coal Mining in New Zealand.

FROM the report of the minister of mines of New Zealand, as quoted in the *Colliery Guardian*, the following brief notes are derived. Comparatively few years ago there were only three mines in the colony where bituminous coal was raised, but at present several others are working or preparing to mine this coal. The total number of collieries of all kinds in 1893 was one hundred and fifty three. A large number of these are merely open pits where lignite is mined for local consumption. Both lignite and brown coal are suited only to this use. So far as known, the whole of the bituminous coal is confined to the west coast of the middle island, and, as this is the only coal suitable for ocean steamers, it is from the mines of this locality that a largely increased output may be looked for. But, before the industry assumes large proportions, foreign markets will have to be found, and for this the superiority of the bituminous coal will have to be relied on, as it cannot compete in price with some other coals. Comparative tests have placed the Westport (N. Z.) coal higher in evaporative power than even the Welsh coals. In 1893 the output from all collieries was 691,548 tons, a small increase over that of the preceding year. The average number of men employed was 1888, with average wages of £107 4s. 8d. ($532).

Gold in Brazil.

BRAZIL, as Dr. J. Branner reminds us in a contribution to the *Engineering and Mining Journal*, was at one time the greatest gold-producing country in the world; but the yield of gold and diamonds was at its height when cheap slave labor was available. This tended to bring mining into disrepute, and to cause it to be considered as degraded and degrading, so that, when the slave trade was stopped, free labor was unskilled, scarce, and also more expensive, wherefore the industry declined. During the last forty years most of the work has been done by single prospectors working with the batea, which of course can only be used with small and very rich placer deposits. The writer quotes from a recent report of Dr. Hussak, a government geologist who has been exploring the high plateau. This authority describes the unworked low-grade deposits, which are (1) lodes and lenticular masses of quartz in mica schists and (2) secondary formations, gravels in ancient fluvial deposits, or the sands of existing streams. Worked on the large scale and with approved modern methods, it is believed that both classes of deposits could now be made to yield a profit.

Metallurgical Progress.

IN an admirable series of reviews of engineering branches in 1894 and forecasts for 1895 the London *Engineer* notes, under head of "Metallurgy," that on the whole there is not much requiring to be chronicled in the metallurgical world on the ground of novelty. In iron- and steel-making the most noticeable feature is the steady increase in size of open-hearth furnaces, these having grown from 15 tons and below to 20 and 25 tons, while 50-ton furnaces are not uncommon. The tendency in blast furnaces is the other way,—to reduce cubic capacity and increase production by larger blowing power and denser blasts. A peculiar form of iron furnace is described, consisting in the

substitution of a stack of nearly cylindrical profile with short low boshes and a wide hearth, terminating above in a bulbous expansion or upper boshes, for the usual continuously curved outline and wide boshes. This is stated to be advantageous,—in one case, with a reduction in contents from 33,000 to 22,500 cubic feet, the make being increased nearly 70 per cent., reaching 1000 tons of iron weekly on hematite ores. The blast is 6½ lbs. per sq. in.

The demand for highly phosphorized metal in the basic Bessemer process has caused a return to value of waste cinder dumps in England; hence a scarcity of phosphorus is possible. In the basic open-hearth process pig iron is not required to be so high in phosphorus as when treated in converters.

A new form of open-hearth furnace of French design to some extent combines in one apparatus the Siemens furnace and the Bessemer converter, the latter being represented by two systems of blast pipes, one set at the roof, the other at the level of the bath. Another French design is a regenerative furnace, in which checker-work is entirely dispensed with, the regenerators being replaced by long parallel flues in a mass of brick-work.

The Schönwalder furnace, about two years ago introduced in Silesia, is intended to increase durability, one thousand to twelve hundred heats having been borne in a 14-ton furnace without renewals. The Saniter process of desulphurizing was used in treating 18,000 tons of pig at a Welsh works, removing from two-thirds to seven-tenths of the contained sulphur at a cost reported as not exceeding 6 pence per ton. Very pure basic steel has been made in the open-hearth furnace.

The Austin process of pyritic smelting has been adopted for the concentration of low-grade copper ores of Newfoundland mines into a product for shipment to Wales for refining. Three tons of ore give in this case 1 ton of regulus (matte?).

Electrolytic refining of copper is gaining in favor, the capacity of the works in America being stated by the *Engineer* as more than 60,000 tons annually. The Anaconda refinery at Butte, Montana, has the largest plant for this purpose at present, but the Calumet & Hecla Co., of Michigan, will have works using the Niagara water-power. Electrolytic refining of doré bullion, to separate gold and silver, is stated by the *Engineer* to be preferable to parting by sulphuric acid. A weak solution of nitrate of silver is used.

The further progress of the cyanid process for gold and silver extraction is noted, as also the substitution of electrolytic precipitation of gold in this process on lead cathodes, in place of precipitation by zinc shavings.

The Boss Rock Drill.

THIS drill is a departure in principle and design from other drills, being an attempt to combine the benefits of rotary motion, as in the diamond drill, with the percussive motion of the drills used in driving blast holes. It is described by its inventor, Mr. J. M. Boss, in a paper read before the Mining Institute of Scotland, of which paper an abstract is given in the *Colliery Guardian*. The drill is not connected with the piston, but with an extension piece. The piston is the only moving part in the tool; it moves with short stroke and very high velocity, striking light but excessively frequent blows upon the head of the extension piece, though the impact is communicated to the drill, and the latter is rotated by a rapid hand-wheel motion.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*28378. The Conquest of Steel Over Cast Iron. Horace L. Arnold (E Mag-March.) 3000 w.

28392. Loam and Dry Sand Molding Compared with Green Sand, as to Its Economy and Adaptation. Simpson Bolland (Ir Age-Jan. 10.) 4000 w.

We supply copies of these articles. See introductory.

28406. The Cyanide Patents. H. Bankart (M S P–Jan. 5.) 1000 w.

*28461. Metallurgy. Editorial Review of 1894 (Eng L–Jan. 4.) 1200 w.

*28469. Irish Aluminous Iron Ores and Aluminum Production. Walter J. May (C G–Jan. 4.) 700 w.

*28509. The Properties of Steel. (Extract.) James Riley (I C T–Jan. 4.) 4800 w.

28554. Improvements in Matte Smelting. Herbert Lang (M S P–Jan. 12.) 4800 w.

28561. Magnesia and Sulphur in Blast Furnace Slag. A. D. Elbers (E M J–Jan. 19.) 1500 w.

*28566. The Metallurgical Trades in 1894. Editorial (M J–Jan. 12.) 2600 w.

28604. Castings and Patterns. Editorial (A S–Jan. 19.) 1100 w.

28643. Relative Tests for Cast Iron. W. J. Keep (F D–Jan.) 1200 w.

28644. Foundry Improvements. Ill. H. M. Ramp (F D–Jan.) 1800 w.

28656. Specifications for Structural Steel. (Clay, Cunningham and Stowell) (Ir Age–Jan. 24.) 5500 w.

*28765. Soldering. Abridged from "The Art of Soldering" by William Probert (I C B–Jan. 18.) 1000 w.

*28770. The Lead Industries of the Tyne. Ill. (C T J–Jan. 19.) 2400 w.

†28836. The Determination of Nickel in Nickel-Steel. E. D. Campbell and W. H. Andrews (J A C S–Feb.) 1500 w.

†28837. The Volumetric Determination of Phosphorus in Steel and Cast Iron. W. A. Noyes and J. S. Royse (J A C S–Feb.) 2400 w.

28875. An Account of Some Tempering Processes. Ill. B. F. Spalding (A M–Jan. 31.) 2800 w.

28887. Big Industrial Operations—A Prediction that Pig Iron Will Be Made at $5 a Ton in East Tennessee. (M R–Feb. 1.) 700 w.

28903. The Effects of Different Elements on Cast Iron. Charles Johnson (Ir Age–Jan. 31.) 1400 w.

28905. The Steel Situation in the Birmingham, Ala., District. C. A. Meissner (Ir Age–Jan. 31.) 1500 w.

28917. Method of Casting Chilled Rolls. Ill. Process of Hermann Reusch and Bernard Preu (I T R–Jan. 31.) 1200 w.

28933. A Possible Explanation of Kernel-Roasting. Henry M. Howe (E M J–Feb. 2.) 1100 w.

28992. Methods of Extracting Gold from Ore. Anon. (T–Feb. 1.) 2000 w.

29015. Manufacture of Brass and Bronze Goods. James Powell (A S–Feb. 2.) 1500 w.

*29030 Dry Concentration. Editorial (M J –Jan. 26.) 1400 w.

*29046. Metallurgical Engineering in 1894. (E Rev–Jan. 21.) 1000 w.

*29056. Nickel and New Caledonia. H. W Sullivan (I C B–Jan. 25.) 2000 w.

29074. A Comparison of Basic and Acid Steel Rails. Abstract by J. B. Nau, of a paper by L. Tetmajer (Ir Age–Feb. 7.) 3800 w.

Mining.

*28376. Mine Management and Superintendence. Covington Johnson (E Mag–March.) 3000 w.

*28398. Progress in Mining. Editorial (M J–Dec. 29.) 1600 w.

*28399. New Enterprises in Gold Mining. Editorial (M J–Dec. 29.) 1200 w.

28407. Mining in Nevada County, Retrospective and Prospective. Anon. (M S P–Jan. 5.) 4000 w.

28415. Mining at Bendigo, Australia. T. A. Rickard (E M J–Jan. 12.) 2000 w.

*28435. Mining in Australia—Suggestions for Gold Prospectors by the Government Geologist. D. W. Marrata (C E–Jan.) 3500 w.

*28467. The Coal Industry of the United Kingdom in 1894. (C G–Jan. 4.) 4000 w.

*28468. The Ross Rock Drill. J. Macewan Ross (C G–Jan. 4.) 1600 w.

*28488. The Metalliferous Mining in 1894. Editorial (M J–Jan. 5.) 1600 w.

28517. A Great Drainage Tunnel—Ontario Silver Mine. (Min R–Jan. 3.) 1500 w.

28550. The Minerals of the Appalachian System. W. M. Brewer (T–Jan. 15.) 2700 w.

28562. Gold in the Highlands of Brazil. J. C. Branner (E M J–Jan. 19.) 600 w.

*28619. A Method of Graduating Test-Tubes for the Determination of Firedamp Content. A. Rateau (C G–Jan. 11.) 1800 w.

*28620. The Bruay Collieries in the Pas-de-Calais, France (C G–Jan. 11.) 2500 w.

*28621. Cast Iron Tubing. (Abstract.) Arnold Lupton (C G–Jan. 11.) 2000 w.

†28660. The Indian Coal Industry—Female Labor. Mr. Grundy's Report (I Eng–Dec. 22.) 1500 w.

*28687. Gold Mining in Victoria (B T J–Jan.) 1200 w.

28704. Gold Mining in Georgia—Present Status of the Dahlonega District. W. G. McNelley (M R–Jan. 25.) 1100 w.

28708. African Diamond Mines.—As Reported by Alfred Hale (M S P–Jan. 19.) 700 w.

28714. The Leadville Gold Belt. Ill. A. A. Blow (E M J–Jan. 26.) 1800 w.

*28727. The Collieries of La Haye, Liège, Belgium. (C G–Jan. 18.) 4500 w.

*28728. Damping Coal-Dust in Mines (Extract.) D. H. F. Mathews, with Discussion. (C G–Jan. 18.) 2000 w.

*28767. Gold Mining on the Colar Field. By One Who Has Studied It (Min W–Jan. 19) 2600 w.

28779. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (A M & I W–Jan. 25.) 1000 w.

We supply copies of these articles. See introductory.

28785. Mining Prospects in Rhodesia. Editorial on Report of John Hays Hammond (M J-Jan. 19.) 1300 w.

28929. The Russian Coal Trade (E M-Feb. 2.) 900 w.

28930. California Placer Gold. Ross E. Browne (E M J-Feb. 2.) 1100 w.

28931. The Basin and Bay State Mining Company. H. M. Beadle (E M J-Feb. 2.) 1000 w.

28939. Mining in California—A Review of the Situation Shows the Industry to Be in a Most Prosperous Condition. W. H. Storms (M S P-Jan. 26.) 2000 w.

28940. Along the Colorado River. Engineer (M S P-Jan. 26.) 900 w.

*28973. Coal Mining in Great Britain. Editorial (Eng L-Jan. 25.) 1500 w.

*28974. Mines and Minerals in the Under Waste Lands. Anon. (C G-Jan. 25.) 3000 w.

*28976. A New Mining Motor. Ill. Henry A. Mavor (C G-Jan. 25.) 1800 w.

*28977. Methods of Working at the Bruay Collieries. J. W. P. (C G-Jan. 25.) 600 w.

*28987. Haulage by Compressed Air Locomotives (I C T-Jan. 25.) 1000 w.

†28995. The Raniganj Coalfield. Ill. (I E-Jan. 5.) 600 w.

29018. The Principal Oil Fields of California (A G L J-Feb. 4) 1200 w.

*29045. Mining Engineering in 1894 (E Rev-Jan. 21.) 1200 w.

29097. Utilization of Culm. From the N. Y. Tribune (W E-Feb. 9.) 900 w.

29098. On the Occurrence of Lignite and Anthracite Around Hudson Bay. Robert Bell (C M R-Jan.) 3000 w.

29100. Mining as an Investment. Robert C. Adams (C M R-Jan.) 4200 w.

29102. The Auriferous Gravels of British Columbia. John B. Hobson (C M R-Jan.) 3000 w.

29103. Notes on Hydraulic Mining in British Columbia. G. M. Dawson (C M R-Jan.) 1400 w.

29104. The Albert Mines and Capelton Chemical Works. S. L. Spafford (C M R-Jan.) 2500 w.

29135. The Minerals of Brazil. J. Ross (E M J-Feb. 9.) 3000 w.

Miscellany.

28713. Gold Production at Home and Abroad. Editorial (E M J-Jan. 26.) 1200 w.

*28729. The Value of Basic Slag as a Manure. (Abstract.) J. E. Stead, with Discussion (C G-Jan. 18.) 3800 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March—11 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—11 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—11 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—11 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27—12 parts to date—30 cts. each).

22710. Science for Ironmongers. Ill. (Irm-Began June 2—15 parts to date—30 cts. each).

25689. A Typical Gold Mine Region—Description of Cripple Creek, Colorado. Ill. Arthur Lakes (C E-Began Oct.—4 parts to date—30 cts. each).

26139. Aluminum. Ill. A. Humboldt Sexton (P Eng-Began Oct. 12—4 parts to date—30 cts. each).

26386. Proper Foundry Construction and the Apparatus to Be Used. Simpson Bolland (T-Began Nov. 1—5 parts to date—15 cts. each).

26826. Open Hearth Steel. Ill. (Ir Age-Began Nov. 15—7 parts to date—15 cts. each).

27329 Coal Mining Economy Up to Date (I C T-Began Nov. 23—5 parts to date—30 cts. each).

27450. Cupola Tuyeres. Edward Kirk (Met W-Began Dec. 8—4 parts to date—15 cts. each).

27700. Aluminium. G. B. E. (I & I-Began Dec. 7—2 parts to date—30 cts. each).

28038. The Extraction of Copper from Alloys by Means of Electrolysis. From Dr. Car Schnabel's Handbook. Ill. (A M S-Began Nov. 24—Ended Dec. 1—2 parts—30 cts. each).

28130. Mining Reports and Mine Salting. Walter McDermott, with Discussion (M J-Began Dec. 22—Ended Dec. 29—2 parts—30 cts. each).

28589. The Mineral Resources of Tasmania. A. Montgomery (A M S-Began Dec. 1—3 parts to date—30 cts. each).

28642. How Iron Is Made. Ill. John Birkinbine, in Cassier's Magazine (F D-Began Jan.—1 part to date—15 cts).

28784. Gold Mining and Milling in the Black Hills (S. Dakota). C. G. Warnford Lock (M J-Began Jan. 19—Ended Jan. 26—2 parts—30 cts. each).

28786. The Mineral Wealth of Siberia; Its Gold Production (M J-Began Jan. 19—2 parts to date—30 cts. each).

28932. Cripple Creek, Colorado. Ill. Edward Skewes (E M J-Began Feb. 2—1 part to date—15 cts).

28975. Charbonnages Unis de L'ouest de Mons, Boussu, Belgium (C G-Began Jan. 25—1 part to date—30 cts).

28978. The Iron Industry in the South of Russia. Paul Bayard (C G-Began Jan. 25—1 part to date—30 cts).

28990. The Mining Industry as a Legitimate and Profitable Business. Milo H. Slater (M I T-Began Jan. 31—1 part to date—15 cts).

29105. Diabase Dykes in the Sudbury Region. T. L. Walker (C M R-Began Jan.—1 part to date—15 cts).

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Emig's System of Water-Supply.

THIS system has for its object the supply of fresher, cooler water than can usually be obtained from the service-pipes in cities. We regard the arrangement as ingenious, and it may prove useful, especially in very warm climates. The illustrated description of it is abstracted from the *Engineering and Mining Journal* (Jan. 26). Fig. 1 represents the entire arrangement, including "a flowing artesian well which has been drilled on the highest elevation near the city or town about to be supplied.

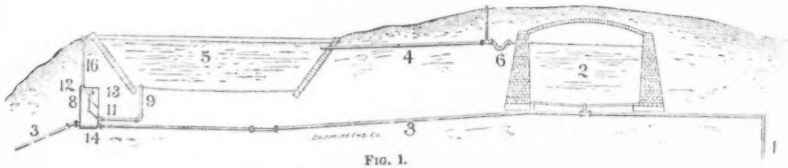
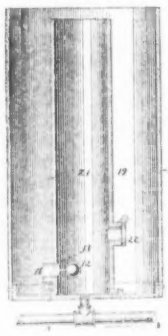


FIG. 1.

The water from the well, instead of coming to the surface, as usual, is turned into the subterranean reservoir, 2, which is far enough below the surface to preserve the water cool and fresh. The water for immediate consumption is drawn from reservoir, 2, through a pipe, 3, which is preferably laid deep enough to be below the influence of surface temperature. The surplus water from the reservoir runs off through a pipe, 4, to a large storage reservoir, 5. The pipe connects with the upper portion of the reservoir so as not to affect its storage capacity, and is provided with a trap, 6, to prevent the passage of air into the reservoir, and a vent pipe, 7, to prevent the water from being siphoned out of the trap. Eight is a valve-chamber in communication with the cold-water main, 3, and 9 a branch pipe leading from the storage reservoir into said chamber.

"The discharge pipe, 9, of the storage reservoir is automatically controlled by a balanced valve, 11, which may put the main, 3, in communication with the storage reservoir, 5, when the water from the subterranean reservoir, 2, is insufficient to supply the demands upon the main; 11 is a balanced valve in the form of a disc turning on its axis. This balanced valve is controlled by a float, 12, in chamber, 8. The float may be connected to the valve in any suitable manner. The stem, 13, of the float is pivotally connected to an arm, 14, which is rigidly connected to the valve. To prevent air from accumulating in the chamber, 8, a small pipe is run up to the surface of the ground.

"The operation is as follows: under ordinary conditions the cold-water reservoir, 2, remains full of water, as do also the main, 3, and the valve chamber, 8. The float, 12, keeps the valve tightly closed. The surplus water at night, and at other times when the demand is light, flows into and fills the storage reservoir, 5. The cold-water reservoir is large enough to meet any demand for household purposes, but, should a fire break out, as soon as it is drained the water in the valve chamber will be lowered, and the weight of the float descending will open the balanced valve, 11, and admit the water from the large storage reservoir into the main. Thus for emergencies the main is automatically put in communication with a large supply of water, while for ordinary purposes the water is supplied to the consumer directly from the well.



"In a level country, where the water must be obtained at about the same elevation as the point of consumption, a double

stand-pipe is used, Fig. 2, which is constructed as follows: 17 is a large stand-pipe, its dimensions varying with the population to be supplied. Twenty-one is a smaller stand-pipe within the larger one. The purpose of this is to preserve the temperature and purity of the water, and is sufficiently large to hold a day's supply. Near the bottom of the stand-pipe is a check valve, 22, which permits water to pass freely from the inner stand-pipe to the outer reservoir, 19, but prevents it from returning. Communication between the storage reservoir, 19, and the cold-water reservoir and main, 3, is controlled by a balanced valve, 11, similar to that shown in the subterranean system, and similarly operated by a float, 12. The valve, 11, is located at or close to the bottom of the storage reservoir.

"The operation of the stand-pipe system is as follows: under ordinary circumstances pure cold water is supplied to the main, 3, direct from the well, and the surplus water is forced through the check valve, 22, into the reservoir, 19. The water is supplied at such a rate that the stand-pipe and tank will be full, thus giving sufficient pressure to the water in the main to raise it to the point of discharge. By the use of the check valve, 22, at the bottom of the stand-pipe the water passes into the storage reservoir, 19, without having to pass over the top of the stand-pipe, and thus much power is saved in filling the outer reservoir. Should the supply of cold water run short on account of stoppage of the pumps, or increased demands, then as soon as the water reaches the level of the float, 12, the latter will begin to descend, and the valve, 11, would be automatically opened, thus putting the main, 3, in communication with the storage reservoir."

The Testing and Care of Water-Meters.

THE use of water-meters has now become so general, especially where some economy in the use of water is needful (this being the case in nearly all large cities), that the question of their accuracy becomes important. In general, when first put in, their indications are perhaps as reliable, within a small percentage of error, as those of gas-meters, but the conditions under which they work are not so favorable to continuous working as are those of gas-meters. An article by Mr. J. C. Whitney, water register of Newton, Mass., in *Fire and Water* (Jan. 26), states concisely what attention ought to be given to water-meters at the time they are placed in service and subsequently.

"Probably the meter has previously been examined by the maker and found to be accurate, but it is important that each department should make its own tests, not only to insure accuracy, but also to have a record which can be produced in case the registration of a meter is doubted by a water-taker. It is suggested that the first test in case of a $\frac{5}{8}$ meter consist in running 5 ft. at the rate per minute stated by the maker to be the greatest proper quantity. On this stream the variation from absolute accuracy should not exceed two per cent. either way. The results obtained from carefully running 5 ft. are as satisfactory as from double that quantity, and the test takes less time and water.

"On small streams it is a question as to the rate of the flow on which the meters should be tried; but perhaps a rate slightly in excess of 1 foot per hour—say 1 $\frac{1}{10}$ ft.—would be satisfactory. The quantity of water run at this rate need not be more than 1 foot, and probably somewhat less than this would answer, the meter being expected to indicate at least 80 per cent. of the flow. In this second test time can be saved by connecting several and running together. This trial on small streams is also of advantage on account of the full water pressure being on the meters, thus showing any leaks which exist in the packing, and perhaps saving a trip to stop an annoying drip in a house-cellar." The results of tests should be recorded in something like the following form,—"name of meter, pattern, size, number of years in use, amount registered to date, length of tests in minutes, size of orifice, number of feet run, weight of water in pounds, percentage registered, reading of meter at beginning and end of test, and the date of testing."

The meter is then put into service and

entered in a record-book, which will give its entire history, including quarterly readings and repairs, and from which the average age, average amount registered, and cost of repairs will be obtainable, thus furnishing all needed data for comparison between meters of different kinds or of the same kind. The extra expense of monthly readings probably outweighs the benefits that readings of greater frequency than once a quarter would secure.

"At least once in two years a special examination should be made as to the accuracy of the meters in use in the system. The examiner is to be provided with a large pail—capacity about 4 gallons—and two brass caps, one having an orifice of $\frac{1}{16}$" diameter, and the other $\frac{1}{4}$". Starting in a street, the first five or six houses are notified not to use any water for half an hour; after assuring himself that no water is being run on the premises, the meter is read, the cap with the orifice is attached to the faucet, and 7½ gallons run, the pail being filled twice. The meter is again read, and any discrepancy noted. The ¼" cap is then disconnected, the $\frac{1}{16}$" cap attached, water turned on, and the meter matched; if it does not start within a minute on this stream, the examiner notes it, and the meter is taken out for repair as soon as convenient. If it has started properly, it is allowed to run ½ gallon, which on our maximum pressure takes about 3 minutes. Ordinary cases can be detected in this way; doubtful ones may be taken out for more thorough examination."

Gas by Electricity.

THE applications of electricity to the industries of the world are each day multiplying, and their possibilities seem infinite. Among the latest of these is the manufacture of gas for illumination. This gas is, however, not the ordinary illuminating gas, obtained by the distillation of coal in retorts; neither is it the so-called water-gas extensively used for lighting. It is also distinct from the so-called producer-gas used largely in gas-engines. Although the substance produced by the agency of electricity may be used for enriching any of the gases named, and although it exists to some extent in illuminating gas obtained from distillation of coal, yet it is capable, by simple intermixture with common air, of making an illuminant of fine quality. The substance is known chemically as acetylene. It is formed by the decomposition of calcium carbid when brought into contact with water. It is in the production of the calcium carbid from which acetylene is obtained that electricity finds a place. Calcium carbid is formed by subjecting a mixture of lime and carbon to a temperature of from 4500° to 5000° F. This temperature is easily obtained in an electric furnace, but, until recent times, the cost of manufacture by heat produced by electricity has been too great for the commercial manufacture of calcium carbid in this way; improvements in dynamo construction have now brought the cost within practicable limits.

The subject has been discussed by Mr. Slocum, in the *American Manufacturer* (Jan. 11), and also by Mr. Francis Wyatt in *The Engineering and Mining Journal* (Dec. 15), who puts the cost of manufacturing calcium carbid by the electric furnace at $15 per ton of 2000 lbs. Mr. Slocum estimates that packing and freight, and a reasonable profit, would bring the cost up to $30 per ton in the general market. The Wilson Aluminum Company, of Spray, N. C., are stated to be now producing it in large quantities. As to the various uses of acetylene, Mr. Slocum says "that, at the present values, benzole-enriching costs approximately two-thirds as much as acetylene, and naphtha-enriching one-third as much, the values being based on present prices, and accepting the formula $Ca C^2$ for calcium carbid and the product produced 100 per cent. pure."

The statement is also made "that the acetylene from 1 ton of calcium carbid, mixed with the proper proportion of air (40 per cent.?), will produce a gas equal to 100,000 cubic feet of 25 candle-power city gas. If 40 per cent. of air is the right mixture, the 1 ton of $Ca C^2$ would produce 17,455 cubic feet of gas. If this gas is equal to 100,000 cubic feet of 25

candle-power gas, it must have a candle-power of 143 candles. This is very interesting; for, when mixed with water gas, it requires 3 grains per candle-power per cubic foot; therefore, to produce 100,000 cubic feet of 25 candle-power gas, it would require 1031 pounds of acetylene, while the light units produced by mixing with air sufficient to equal this only require 720 pounds of acetylene, or, practically, two-thirds as much. The use of acetylene in carbureting water-gas, therefore, is 50 per cent. dearer than when air alone is used with it. It does not seem, after carefully reviewing the above, that acetylene will be used for carbureting purposes in the ordinary gas works of the country. With proper apparatus, however, it can be most profitably used for small isolated lighting, such as seaside hotels or country homes, and will make a most valuable enricher for producing a very high candle-power gas for railroad-car lighting. This last is very important to the gas companies, for it is only necessary to get a compressor and receiver to produce, and supply the railroads with, a very much more satisfactory gas even than that used now in the Pintsch light. The light will be of a higher and more even candle-power, and not subject to a separation by oversaturation."

Philadelphia Highway Improvements.

THE *Proceedings of the Engineers' Club* of Philadelphia contains a paper by Mr. George A. Bullock, on "Highway Improvements in Philadelphia," which, when read before the club, elicited a spirited discussion and brought out some facts worth notice. There are 1325 miles of streets and roads open and in use in the city, of which 869 miles are paved, 426 miles unpaved, and 30 miles are turnpike roads. In December, 1881, an ordinance was passed prohibiting the use of cobble or rubble for paving, and also prohibiting the paving of gutters with brick. The ordinance, however, did not apply to space between tracks of any passenger railway, and it did not affect then existing contracts.

Mr. Bullock says: "The change from block to asphalt paving, and the consequent transformation in the condition of our streets during the last two years, have been due to legislation made by city councils. As a partial compensation for valuable franchises, the passenger-railway companies have been obliged to pave most of our principal streets, and as a result they are now in excellent condition. The railway companies are now operating on 382.64 miles of streets. Another improvement which has been gradually carried forward is the rounding of all street corners. Before this was done, a team could not turn the sharp corner without the horses running into any other vehicle that might be on the track in the middle of the street."

It is estimated that to pave with asphalt the small streets now paved with cobble and rubble will cost from $15,000,000 to $17,000,000; but Mr. Bullock thinks the needed amount will be gradually appropriated and the work will ultimately be done. The street-lighting system is spoken of as "probably the best now in the world." "Not long since a delegation was sent from Paris to inspect it with a view of copying some of its details. Our new building law, although not perfect, contains many improvements over the old law, one of the most important of which is prohibiting the projection of bay windows or fences beyond the building line." Mr. Bullock thinks the time "is near when Philadelphia will be one of the best-managed cities in the world, as it now has the proud distinction of being the one where most citizens live in their own houses."

It has been found that "in asphalt block pavements the blocks rot at the bottom on account of capillary attraction of the moisture from the soil. With proper foundation, however, these blocks make an excellent pavement." In the further discussion it was brought out that the price of gas in Philadelphia differs from that in Berlin, and that there is only a trifling difference in the cost of electric light and water. The cost of maintenance of paving is about three times as much in Berlin as in Philadelphia, but the work is done correspondingly better.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

*28385. Strains in Gasholder Guide-Framing. F. S. Cripps (J G L-Jan. 1.) 900 w.

*28466. Gas Supply. Editorial (Eng L-Jan. 4.) 1500 w.

28481. Gas by Electricity. Ill. F. L. Slocum (A M & I W-Jan. 11.) 1100 w.

*28574. The Efficiency of Non-Luminous Combustion. B. H. Thwaite (J G L-Jan. 8.) 1800 w.

*28666. The Report of the "Lancet" Commission on Incandescent Gas Lighting (J G L-Jan. 15.) 2600 w.

*28667. Dr. Lunge on the Assay of "Refined" Tar (J G L-Jan. 15.) 1500 w

*28739. The Commercial Synthesis of Illuminating Hydrocarbons. Vivian B. Lewes, with Discussion (J S A-Jan. 18.) 6000 w.

*28773. Oil-Gas Enrichment at Huddersfield. William Young (G W-Jan. 19.) 2000 w.

*29007. Oil-Gas Enrichment at Huddersfield. W. R. Herring's Reply to Mr. Young (G W-Jan. 26.) 500 w.

*29008. Interview with Mr. William Young (G W-Jan. 26.) 7200 w.

*29014. Gas of 240-Candle Power—A Sensation—Comments on Vivian B. Lewes' Paper, "The Commercial Synthesis of Illuminating Hydrocarbons" (J G L-Jan. 22.) 1800 w.

29019. How to Burn and How to Save Gas. (Abstract.) W. R. Herring (A G L J-Feb. 4.) 1800 w.

Sewerage.

*28372. Sewers and Sewage Disposal. Rudolph Hering (E Mag-March.) 3000 w.

28519. The Siphon of Clichy-Asnieres. Ill. From La Nature (Sc A S-Jan. 19.) 1200 w.

*28981. Tests of Cement Joints for Pipe Sewers. Ill. Freeman C. Coffin (J A E S-Dec.) 4000 w.

29131. Deer Island Sewerage Works, Metropolitan Sewerage System, Boston, Mass. Ill. (E R-Feb. 9.) 2000 w.

Streets and Pavements.

*28373. Pavements, Sidewalks, Roads, and Bridges. Ill. J. W. Howard (E Mag-March.) 3800 w.

28670. The Boulevard La Fayette, in the City of New York. Ill. (Sc A-Jan. 26.) 1100 w.

†28788. Highway Improvements in Philadelphia. George A. Bullock, with Discussion (P E C P-Jan.) 1600 w.

*28982. The Asphalt Question. S. F. Peckham (P-Feb.) 3500 w.

*28983. How to Determine the Merits of Asphalt—Opinions of City Officials (P-Feb.) 4500 w.

Water Supply.

28426. The Water Scare in Worcester, Mass. (E R-Jan. 12.) 1300 w.

*28465. Water Supply. Editorial Review of 1894 (Eng L-Jan. 4.) 2000 w.

28537. The New Water Supply of Los Angeles. Ill. William Mulholland (E N-Jan. 17.) 900 w.

28559. Bore Hole Wells for Town Water Supply. Ill. Henry Davey (F W-Jan. 19.) 1600 w.

28715. Emig's System of Subterranean Water Supply. Ill. (E M J-Jan. 26.) 600 w.

28755. The Care of a Water Meter. J. C. Whitney (F W-Jan. 26.) 750 w.

†28787. The Filtration of Public Water Supplies. Henry Leffman, with Discussion (P E C P-Jan.) 4500 w.

28883. The Girard, Kan., Water Tank. Ill. (E R-Feb. 2.) 700 w.

28891. The Water Meter as a Sanitary Appliance. Editorial (E N-Jan. 31.) 1000 w.

29089. A Contractor's Opinion of the Jersey City Water Specifications (E N-Feb. 7.) 1000 w.

Miscellany.

†28390. The Work of the London County Council. Sidney Webb (C R-Jan.) 8500 w.

*28464. Sanitary Engineering. Editorial Review of 1894. (Eng L-Jan. 4.) 1500 w.

28754. Fire Departments and Municipal Governments. Gardner Kellogg (F W-Jan. 26.) 1800 w.

28781. How to Supply Our Condensers with Water. John Mabbs. Read before the Robert Fulton Association, N. A. S. E. (S E-Jan.) 2800 w.

*28819. The Elements of Good Citizenship. Fred de Land (A M C-Feb.) 3300 w.

*28821. What the Citizen Owes the State. L. W. Keplinger (A M C-Feb.) 2100 w.

*28822. Civics: A Science for Citizens, and a Creed for Patriots. Henry Randall Waite (A M C-Feb.) 1500 w.

29120. Why Municipal Plants Succeed and Why They Fail. A. E. Winchester (E E N Y-Feb. 6.) 700 w.

Serials.

14839. Water Purification in America (E N-Began Aug. 3, 1893—16 parts to date—15 cts. each).

26221. The Manchester Thirlmere Waterworks (Eng L-Began Oct. 19—4 parts to date—30 cts. each).

27636. The Economic Principles of the Gas Producer. Anon. (M W-Began Dec. 7—3 parts to date—30 cts. each).

28762. Filtration and Purification of Water. Ad. Kemna (I C B-Began Jan. 18—2 parts to date—30 cts. each).

28780. The Artificial Production of Gas as a Fuel. Joseph A. Minturn (A M & I W-Began Jan. 25—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

RAILROADING

The Gas-Tramway at Dessau.

THE latest innovation regarding means of propulsion on tramways is the application of gas motors directly to cars. A description of Luhrig's system, as carried out on a tramway at Dessau, is presented in the *Journal of Gas Lighting* (London Jan. 1), from advance sheets of *Journal fur Gasbeleuchtung*. The gas-tramway at Dessau commenced regular running on November 15. It is 2¼ miles in length, consisting of two sections,—one 1.55 miles long, the other 0.20 miles. The track is formed with "Phœnix No. 7" grooved rails, set to a standard gage of 4ft. 8½in., and has many sharp curves,—one to a radius of only 40 feet. Besides several easy risers, there is one about 150 yards long, with a gradient of 1 in 30, ending in a sharp curve. The first (longer) section was opened on the above date; the second, on December 6. The provisional rolling-stock is nine gas-motor cars on Luhrig's system. Under one seat of the car is a gas-engine of 7 h. p., the two cylinders of which lie horizontally opposite one another, the pistons working on a common crank axle. The engines are furnished with valve motion and electric igniting apparatus, and were provided by the Deutz Gas-Motor Works.

"The chamber containing the motor is tightly closed beneath and on the inside; but on the outside there are a large folding-door and two small flaps giving access to it. When the doors are shut, the position of the engine is indicated only by the semi-circular depression in the casing for the accommodation of the fly-wheel. From the opposite side the car presents the appearance of an ordinary horse or electric car. The spent gases from the engine are expelled beneath without noise. The gas used (ordinary illuminating gas, compressed) is carried by the car in three stout-walled wrought-iron reservoirs, of which the largest is beneath the seat on the side of the car opposite to the engine, the two smaller ones being placed under the body of the car before and behind the wheels. The three holders have a united capacity of 28 cubic feet, and they are filled with gas to a pressure of six atmospheres."

The Dessau cars carry about 66 gallons of water for cooling, and weigh, in running order, about 6 tons, which may easily be reduced in the future. The cars seat twelve persons inside and fifteen outside, thus carrying, with the conductor, twenty-eight people. The speed can vary at will, within wide limits, but the regulations of Dessau permit a maximum of only 7½ miles per hour. A lever on the platform controls the speed. The reversing-gear lever is adjacent, and the brake-handle, with a bell indicator, is also near by. "The trial trip that preceded the opening of the line showed that the cars were easily managed, and that the brake would pull up a car in 2¼ yards when running at the maximum speed. When the car is running, the engine works at the rate of two hundred and fifty revolutions. During short stops it runs free at eighty revolutions, but during long stops it is pulled up and restarted by turning the fly-wheel,—an office easily performed by the conductor.

"At the terminals of each section are two compressing stations, where the gas taken from the street-mains is compressed. The stations consist of a small house, covering a space of about 15 × 15 ft., containing a gas-engine of approximately 8 h. p. coupled directly to the gas-pump. Under a projection roof outside the house are two large boiler-shaped receivers for the gas (compressed to eight atmospheres), as well as the coolers for the gas-engine. From each station a service runs to the street tram-line, where the compressed gas is drawn off from a stand-pipe."

The results are stated to be very satisfactory and encouraging. Immunity from accidents is anticipated from the fact that, although there are no less than twenty-six

thousand gas-engines continually at work in Germany, and the majority of German railway-cars are lighted by gas compressed in reservoirs, the explosion of a gas engine or gas reservoir on a railway-car is unheard of.

European Locomotive Boiler Practice.

THE following summary is abstracted from a review in the *Railroad Gazette* (Jan. 11) of a report on European boiler construction by M. Ed. Sauvage, published in a bulletin of the international Railroad Congress Commission.

The use of soft steel sheets for the shells of locomotive boilers is current practice, and it is justified by the fact that these sheets are more uniform in quality than those of iron. The steel should be very soft, as shown by tensile strength, which should not exceed 64,000 lbs. per square in., and should lie between 50,000 lbs. and 57,000 lbs. The plates should come from the best raw materials, and be as free from phosphorus as possible. The use of steel in the place of iron sometimes permits an increase of pressure without increasing the thickness. The manipulation of soft steel sheets does not require great precaution, because they will stand local heating and bending. A desirable precaution is that of annealing the sheets after working and before riveting up. This is not always necessary where long experience has proved the constant quality of the material, and where the workmen are known to be reliable and accustomed to handling steel boilers.

Steel fire-boxes continue to be almost unused in Europe. Some trials have been made which do not indicate that they are much more economical in service than copper,—at least not with the qualities of steel obtainable in Europe. However, with small locomotives having comparatively little work to do, steel fire-boxes may be very advantageous. Tubes of iron or steel are being more and more employed in the place of brass. This substitution may be made without inconvenience, and is a great economy. It is useless to solder an end section of copper on tubes of iron or steel. The iron and steel tubes are rolled or expanded by a mandril in the holes in the tube sheets which are made cylindrical or slightly conical.

The riveted-over part, or bead, on the ends of the tubes at the tube sheet, is not absolutely necessary or indispensable. The ferrules for the ends of the tubes should only be used on the fire-box end. Generally speaking, damage to the tubes can best be prevented by care in handling the boilers. When the tubes are correctly put in, they will give no trouble when the firing is regular and the entrance of the cold air to the fire-box is prevented as much as possible. Boilers should be cool before being emptied, and especially before washing with cold water. It is bad practice to draw the fires before entering stations, as this lets cold air into the fire-box and injures the tubes. Boiler compounds for reducing scale are useful for preventing hard deposits, but the composition must be selected to suit the local conditions and the nature of the water. Purification before using feed-water that is rich in carbonate of lime, and, above all, water containing selenites, is useful, but this plan requires a large outlay for apparatus; yet it often happens that the saving in fuel and boiler repairs and washing gives a final important economy. The introduction of the feed-water into the steam space, which rapidly removes the air from the water, and prevents local cooling of the plates, is worthy of trial.

Locomotive tubes are generally not longer than 13 to 16½ ft. The area of the passage through the tubes ought to be as large as possible, and this justifies omitting the ferrules inside of the tubes at the ends. The diameter of tubes should not be too small, and they should not be brought too close together. The inside diameter should be from 1.6 to 2 in., and the distance between the tube holes in the sheets should not be less than .6 to .7 in. The tubes with wings on the interior, such as those of the Serve type for locomotives, have an outside diameter of 2.4 to 2.8 in., because tubes smaller than this are generally made in too short lengths. It is, perhaps, advantageous to substitute tubes with wings for the ordinary tubes of 2 in.

in diameter, but in that case the number of wings, or the size, should be reduced. The relative efficiency of tubes arranged at the corners of a square,—that is, in vertical and horizontal rows,—and those arranged at the corners of the square with one tube in the centre of the square,—that is, in vertical rows, and not in rows horizontally,—is about the same. Preference is generally given to the arrangement in both vertical and horizontal rows. It is not apparent that there is any particular difference in the capacity of boilers to generate steam, no matter what the metal of the tubes may be,—that is, whether it is copper, iron, or steel.

The effect of the volume of the smoke-box is scarcely appreciable. The long smoke-boxes, such as are used in America, have been tried in Europe by many railroads, but do not seem to give better results than shorter boxes. It seems preferable to use the shorter box. It is not apparent that there is any marked superiority with any type of smokestack. The slightly conical form, wider at the top, seems to be preferred. It is well to prolong the stack into the interior of the smoke-box, using a funnel form for the interior. The height of the exhaust nozzle ought not to be much more than the upper row of tubes.

Almost any form of spark-arrester is, of course, an advantage in reducing sparks, but all interfere with the draft more or less, without being absolutely spark-proof. The simple netting suffices in most cases. The annular exhaust nozzle seems to be the best, but it is complicated in design when the exhaust is made variable. The exhaust nozzle of single blast pipes should be variable, but it is best that the variation does not permit too much reduction in the size of the nozzle. No doubt it is on account of permitting too much reduction of the nozzle that the variable exhaust has been sometimes pronounced injurious or useless. The simple design of two movable wings seems all that is necessary. The height of the exhaust nozzle should not exceed much the top row of tubes, even when the stack is not prolonged into the smoke-box.

The speed has no apparent influence on the production of steam. In other words, the quality of the weight of steam escaping per second with the same terminal pressure in the cylinders is the governing condition. The frequency of the blast has no particular effect. This is shown by the action of compound locomotives with two cylinders.

Gas Jackets for Locomotive Cylinders.

THE *Railway Review* (Jan. 19) reprints from *Engineering* (London) an account of a new system of jacketing locomotive cylinders introduced by L. T. de Kossuth, engineer-in-chief on the Italian State railways. The mechanical details of the system illustrated show that the engines to which the system has been adapted have outside cylinders, to the exteriors of which are fitted casings of metal in two parts, one of which is removable. The casings are made of iron plates with a layer of asbestos interposed between them. Space is left between the casings and the exteriors of the cylinders, and through this space waste gases of combustion are circulated, these gases being conveyed into the jackets by pipes leading from the smoke-box to the casings. These pipes at the smoke-box end are bell-mouthed, and the impetus imparted by the exhaust to the gases forces a portion of them into and through the pipes, and into and through the space under the casings, and through another pipe into the exhaust. The removable half of the casing is for the purpose of cleaning out accumulations of dust,—an operation required every few days. Uniform circulation of the hot gases in the jacket spaces is secured by an ingenious arrangement of diaphragms placed in the spaces.

"This apparatus has been applied on a considerable number of engines in Italy, as well as on locomotives on French and Hungarian railways. A large number of official trials have been made, with a view of ascertaining whether the arrangement offered any advantage in economy of working; and some facts are selected from published results which are of interest and appear representative. The engine referred to is one belonging to the Mediterranean

section of the Italian State railways, and has the following leading proportions: fire-box surface, 89.34 sq. ft.; tube surface, 1.248 sq. ft.; grate area, 17.22 sq. ft.; working pressure, 135 lbs. per sq. in.; diameter of cylinders, 17.72 in.; length of stroke, 25.6 in.; diameter of wheels, 52.36 in.; total weight in working order, 39.4 tons; ratio of steam admission, 25 per cent.

"The maximum steam pressure at commencement of stroke was 118 lbs. per sq. in. without reheating. The mean pressure during the stroke was 62.93 lbs. in the former case, and 56.5 lbs. in the latter. These results indicate an economy of 6.43 lbs. per sq. in. in favor of Mr. Kossuth's arrangement. In another series of trials on the same engine, and with a cut-off of 20 per cent., the economy recorded was shown by an increased steam pressure equal to 7.8 lbs. per sq. in. during the stroke. The result of several months' regular service with an engine fitted with the reheating apparatus established an economy in fuel of 11 per cent., as compared with the work done by the engine without the heating device, and with other locomotives of the same type doing similar work. The very interesting facts that have been recorded in the extended trials referred to, and which were of an official character in all cases, together with the distinguished name of the inventor, will probably lead to a practical test of the system in the United States."

Wheel Base for Street Cars.

ENGINEERING NEWS (Jan. 24) calls attention to the fact that increased weight and speed of street cars in the cable and trolley systems of propulsion have rendered it desirable to use double four-wheeled trucks in place of the "short and rigid wheel base" universally employed on street cars drawn by horses. It further states that the four-wheel pivoting trucks first tried have been found unsatisfactory, and that attempts to design the desired extended and flexible wheel base, suited to the needs of these cars, have failed in numerous instances. It prints an abstract of an article by Mr. John A. Brill in the *Street Railway Journal*, describing a design for a four-wheeled truck for eight-wheel street cars manufactured by a Philadelphia firm, and discussing general principles and recent practice in respect of trucks for street-railway cars.

"The general disposition of managers of electric roads is to put cars with 20 or 22-ft. bodies, and 28 to 30 ft. long over all, on four-wheeled trucks. Long cars mounted on four-wheeled trucks, while they possess advantages as regards traction on extra heavy grades over those mounted on centerpivotal trucks, are extremely expensive to keep up. In the first place, no matter how superior the road-bed construction may be, it cannot be mathematically perfect. A long car mounted on four-wheeled trucks is bound to gather at times an oscillating or pitching motion. A moderately-extended spring base has an effect of mitigating this oscillation to passengers, but the pounding on the roadbed is greatly increased by the pitching on the short-wheel base, and cannot be overcome. The result is that for every jump of the car the roadbed suffers. On all tracks there are places beside the curves at which one rail is elevated above the other. The long spread of a truck with 6 or 7 ft. wheel base, as compared with 'maximum traction' trucks having wheel base of 3½ to 4 ft., takes in a large amount of this difference in elevation, and exaggerates the distortion from parallelism of the driving axles and motors. It thus causes a binding of gear wheels, as well as a more rapid wearing away of the cogs, and retards the movement of the motors, thus causing far more strain on the main electric outfit. In my judgment, cars with 18 ft. bodies are the longest that should be used on four wheels. Longer cars should be mounted on 'maximum traction' trucks, so as to overcome all oscillation and the objectionable pounding referred to above. The recent inventions in this style of truck, from which it derives its name, provide for 87 per cent. of the weight on the driving wheels and the remaining 13 per cent. on the trail wheels, just sufficient on the latter to keep them on the track should slight obstructions been countered. The trail wheels being

small, and the pivotal center of the truck being within the periphery of the driving wheels, in passing around curves the driving wheels 'radiate' within the car bottom, while the trail wheels 'radiate' entirely beneath the car body, with the bottom frame not exceeding 6 ft. 2 in. for a standard gage track. The height from under size of sill to line of rail is as low as 27¼ in., being ½ in. lower than on regular four-wheeled cars. Another advantage consists in the facility for repairing a damaged motor. One end of the car body can be jacked up, and the single motor and truck run out for repairs, by merely disconnecting the motor leads. If the damage is of a permanent nature, the truck and motor can be replaced by another in a very short time." As to power required to propel street cars with double trucks as compared with cars having single trucks, able engineers positively assert that the double truck has not entailed increased power for haulage.

Electric Locomotives.

WE cannot yet agree with the *Boston Journal of Commerce* that the storage battery has been so far improved that it could now be profitably substituted for the trolley for any kind of railroad, as that journal asserts in its issue of Jan. 19. At the same time our faith in the ultimate triumph of the storage battery does not wane, although we believe that it must yet undergo considerable improvement before it can supplant the trolley system. There are some objections to propulsion by the trolley, but the advantages so far outweigh disadvantages that, until this device meets a more powerful rival than the storage battery of the present, it will hold its ground. For street-railway traffic the electric trolley, taken by and large, is the best means of propulsion yet devised by human ingenuity; but it will not always be so, and all indications strongly point toward the storage battery as the next great step in car-propulsion. And the extension of electric propulsion from street railways to the long lines now using steam locomotives seems also only a question of time. The next generation will, in all probability, ride between distant stations in electrically-propelled, -lighted, and -heated cars, and the locomotive of the present will live only in books and museums. Passing over what has been done in the United States toward effecting this revolution, already familiar to readers of technical journals, it seems that the tendency in Europe is setting even more strongly toward electric propulsion than on this side of the Atlantic.

"Recent information from Europe shows that electric locomotives are becoming rivals of the steam machine, not only for tunnels, but on the long lines of surface railroads. Some two years ago the Heilman locomotive was placed on the tracks as an experiment, and it has proved so satisfactory that one of the older railroads is reported to have ordered several of these engines constructed for its use. This machine, however, is not properly an electric locomotive, as it carries the usual boiler and engine to run the dynamo that furnishes current for operating the motors which give motion to the wheels on the track. There is said to be a great gain in this form of locomotive in the steadiness of movement derived from the electrical balance. Late scientific journals in London report that one road at least has positively adopted electric traction. This is the Paris-Lyons-Mediterranean Railway, which, according to *The Engineer* (London), is now building sixty electric locomotives, each capable of drawing eight hundred tons at a speed of fifteen miles per hour."

The Luehrig gas motor, elsewhere spoken of in this department, is, in the opinion of many, likely to prove a formidable rival to electric propulsion, but it seems yet too early to speak with confidence as to its possibilities.

Electric Traction in Europe.

APROPOS of what is said elsewhere in this department regarding the probably near substitution of electric motors for steam locomotives on long lines of railway, and also as sustaining the position that trolley systems are not in immediate danger of being driven out of use by storage-battery motors, a paper contrib-

uted to the *Electrical Review* by Mr. Phillip Dawson may be quoted. He says that "the work that has been done, and is about to be undertaken, on the continent is quite sufficient to show the signs of the times. We have repeatedly been told that the trolley car and the trolley wire, so greatly in vogue in America, were hopelessly unsuited to European conditions, and could never find anything like the same general acceptance that has been extended to them on the other side of the Atlantic. The statistics that are to-day available go far to disprove that assertion, and it may now be confidently predicted that by the end of 1895 Europe will be well on the way toward as general an introduction and as wide a use of electrical motive power for both metropolitan and suburban passenger traffic as now maintains in America.

"Nearly 1100 electric motor cars are now in regular operation on the continent alone, employing about 20,000 h. p. in station engines, and approximately 400 miles of track have been electrically equipped. Moreover, contracts are already signed for nearly 500 more motor cars, 12,000 additional engine h. p., and 350 miles of track construction."

Contrary to experience in some of the cities of the United States (notably Brooklyn), Mr. Dawson states that freedom from accident is a marked feature of electric railroading in both Europe and America. This seems to indicate that the accidents of which Brooklyn citizens complain are due, not to electric traction as a system, but to defects in the management of the roads. "On the Halle line in Germany there has been only 1 accident to life or limb for every 88,638 car-miles run. The Berlin horse tramway statistics show 1 accident to every 41,625 car-miles. It may be also said that the speed of the electric cars is much higher than that of the horse cars. These figures are amply supported by American results. In Boston the statistics show a single accident to every 52,475 electric car-miles run. In the State of Massachusetts in 1893 one passenger out of every 686,662 carried was injured, and one fatality occurred for every 106,776,004 passengers carried by the electric lines. The larger part of these accidents were caused by passengers jumping from the cars before they were brought to a stop." Speeds of from 12 to 15 miles per hour are common on country tramways in Europe.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*28369. Relations of the Employee to the Railroad. Cy Warman (E Mag-March.) 3000 w.

*28370. Relations of the Railroad to Its Employees. W. H. Canniff (E Mag-March.) 3000 w.

*28384. The Gas Tramway at Dessau. W. von Oechelhaeuser (J G L-Jan. 1.) 2000 w.

28417. An Interesting Report on European Locomotive Boilers. Abstract of report by M. Ed. Sauvage (R G-Jan. 11.) 1000 w.

28418. Suggestions for Rapid Transit in New York. Extracts from J. J. R. Croes, with Editorial (R G-Jan. 11.) 2200 w.

28419. Passes in the State of New York. Editorial (R G-Jan. 11.) 1600 w.

28420. The Bulging of Fire-Box Sheets. Editorial (R G-Jan. 11.) 1500 w.

28421. Locomotive Counterbalancing. (On the report of Committee to S. & S. R'y. Club) (R G-Jan. 11.) 1500 w.

*28441. Hobart Electric Tramways (Tasmania). Ill. (R W-Jan.) 1200 w.

*28442. Electric Traction, with Special Reference to the Installation of Elevated Conductors. Ill. Robert W. Blackwell (R W-Jan.) 4400 w.

*28451. Electric Traction in Europe. Ill. Philip Dawson (E R L-Jan. 4.) 1200 w.

*28452. The Present Position and Prospects of Electric Traction in this Country. M. Holroyd Smith (E R L-Jan. 4.) 2400 w.

*28472. A Series System of Electric Traction for Agricultural Light Railways. Nelson W. Perry (El-Jan. 4.) 2000 w.

28489. Investigating the Brooklyn Trolley System (S R G-Jan. 12.) 2000 w.

*28499. French Railway Servants. Editorial (E-Jan. 4.) 2600 w.

28512. The Pooling Bill.—Extracts from Joseph Nimmo, Jr. (R R-Jan. 12.) 1500 w.

28513. The Railroad Situation.—From the Report of the Board of R. R. Com. of the State of N. Y. (R R-Jan. 12.) 1000 w.

We supply copies of these articles. See introductory.

28515. State Regulation of Railroad Rates. Editorial (R R–Jan. 12.) 2000 w.

28525. The Supplementary Wire for Electric Railways. H. S. Wynkoop (E E N Y–Jan. 16.) 1000 w.

28536. Stone Arch Under the N. Y., N. H. & H. R. R. at Pelhamville, N. Y. Ill. (E N–Jan. 17.) 800 w.

28538. Progress in Removing Grade Crossings (E N–Jan. 17.) 1800 w.

28539. Cheaper Railways in England. Editorial (E N–Jan. 17.) 1500 w.

28541. New Railroad Projects in England. W. M. Acworth (R G–Jan. 18.) 1500 w.

28543. Electric Conductors in Brooklyn—Report of the Board of Commissioners of Electrical Subways (R G–Jan. 18.) 2500 w.

28544. Light Railroads in England. Editorial (R G–Jan. 18.) 2000 w.

28545. Speed Limits for Electric Street Cars (R G–Jan. 18.) 1200 w.

28564. Electric Locomotives—How They Are Coming into Use on Steam Railroads (B J C–Jan. 19.) 1700 w.

*28588. The Light Railway Question (Tr–Jan. 11.) 4000 w.

*28599. The Government of Turbines Driving Railway Generators. Mark A. Replogle (S R R–Jan.) 1800 w.

*28600. The Three-Wire System at St. Louis. Ill. (S R R–Jan.) 2200 w.

*28601. Electric Street Car Ambulance. Ill. (S R R–Jan.) 1400 w.

*28602. Convenient Methods for Measuring Small Resistance and Insulation Resistance with Volt and Ammeter. Ill. W. C. Fuchs (S R R–Jan.) 900 w.

*28603. Suburban Railways and Their Possibilities. Charles M. Swift (S R R–Jan.) 2200 w.

28607. Heating on Elevated Railroads. Ill. (H & V–Jan. 15.) 900 w.

*28616. Revision of Railway Fares. Editorial (E–Jan. 11.) 2000 w.

*28636. Light Railways. Editorial (Eng L–Jan. 11.) 1200 w.

*28638. Railway Speeds. Editorial (Eng L–Jan. 11.) 1500 w.

*28645. The New Zealand Midland Railway (Ry T–Jan. 12.) 900 w.

28651. Hot Gas Jackets for Locomotive Cylinders, with Editorial. Ill. (R R–Jan. 19.) 1500 w.

28671. The Transandine Railway and Interandine Trunk Lines. Courtenay de Kalb, in the Independent (Sc A S–Jan. 26.) 2500 w.

28681. A Storage Battery Electric Railway and Lighting Plant. G. Herbert Condict (E W–Jan. 26.) 900 w.

*28686. The Railways of the United States (B T J–Jan.) 1800 w.

28693. Locomotive Boiler Efficiency (Synopsis). Ill. George Marié, with Editorial (R G–Jan. 25.) 3500 w.

28697. A Pressed Steel Truck Bolster. Ill. (R G–Jan. 25.) 1200 w.

28697. Specifications for Electric Railway Construction—Waukesha Beach Electric Railway (E N–Jan. 24.) 2800 w.

28698. The Luehrig Gas-Motor for Street Railways. Ill. Frederick A. Kummer (E N–Jan. 24.) 1100 w.

28700. Rigid or Flexible Wheel-Base for Street Cars. (E N–Jan. 24.) 1100 w.

28701. The Proposed Change in Car Interchange Rules. Editorial (E N–Jan. 24.) 900 w.

28778. Investigation of the Electrolysis of Pipes by Escaping Electric Railway Currents in Brooklyn. John A. Barrett (S R G–Jan. 26.) 2800 w.

28795. Storekeeping. S. F. Forbes (R R–Jan. 26.) 2500 w.

28799. Responsibility for Damages Under the Law. Editorial (R R–Jan. 26.) 1400 w.

*28844. Steps Toward Government Control of Railroads. Carroll D. Wright (F–Feb.) 4500 w.

*28847. Power Required in Electric Traction Under Varying Conditions. James Lyman (S J E–Jan.) 4000 w.

28866. Rapid Transit in New York. Immediate Rapid Transit. (R G–Feb. 1.) 1400 w.

28867. Fuel Saving on Railroads. Extracts from paper of William Forsyth, with Discussion. (R G–Feb. 1.) 6300 w.

28868. The Expert Board on Rapid Transit. (R G–Feb. 1.) 2200 w.

28869. The Proposal to Abolish Grade Crossings in New York. Editorial (R G–Feb. 1.) 900 w.

28870. Limiting the Size of Freight Cars. Editorial (R G–Feb. 1.) 900 w.

28871. Freezing Out Scalpers and Thieves. Editorial (R G–Feb. 1.) 900 w.

28873. A Year of the "Alley" Elevated Railroad. (R G–Feb. 1.) 800 w.

28874. Fires Caused by Sparks from Locomotives. Editorial (R A–Jan. 25.) 1200 w.

28890. Steel Axles. Abstract of Paper by Lewis R. Pomeroy (E N–Jan. 31.) 1800 w.

28892. The Reno System of Tunneling for a Rapid Transit Railway. Ill. J. W. Reno (E N–Jan. 31.) 1200 w.

†28896. The System of the Binghamton Railroad Company. Ill. (S R J–Feb.) 3500 w.

†28893. Wheel Metal. Ill. W. E. Partridge (S R J–Feb.) 3200 w.

†28899. Street Railway Wheels. Charles F. Uebelacker (S R J–Feb.) 1000 w.

†28900. Some Figures in Regard to Car Wheel Mileage. W. E. Partridge (S R J–Feb.) 800 w.

†28901. The Metropolitan Elevated Railway, Chicago. Ill. (S R J–Feb.) 1800 w.

†28902. Notes on Feeder Cables for an Electric Railway. M. Ward Easby (S R J–Feb.) 1400 w.

We supply copies of these articles. See introductory.

28910. Economic Street Railway Maintenance—The Repair Shop. Keppele Hall (E W-Feb. 2.) 2000 w.

28911. Street Railway Overhead Appliances. Ill. A. G. Eneas (E W-Feb. 2.) 2000 w.

28912. A Theory of Electrolysis. Alfred H. Bucherer (E W-Feb. 2.) 3000 w.

*28919 The Locomotive Boiler. W. H. Weston (N C B-Feb.) 1900 w.

*28920. Some Indian Rolling Stock. Ill. (N C B-Feb.) 1400 w.

*28921. Proper Shape of Smokestacks. Ill. Master Mechanic (N C B-Feb.) 1100 w.

*28922. Notes on English Railway Practice. F. A. Delano (N C B-Feb.) 2800 w.

28923. A Modern Locomotive Works—The Juniata Shops of the Pennsylvania Railroad. Ill. Fred H. Colvin (M A-Feb.) 1500 w.

28924. A Device for Feeding Boiler Scale Resolvent. Ill. William H. Wakeman (M A-Feb.) 600 w.

*28936. Aerial Railways. From the London Spectator (A E R J-Feb.) 1100 w.

*28937. Logging Railroads. Ill. (A E R J-Feb.) 1400 w.

28945. The Crossing of the Central Railroad of New Jersey and the Pennsylvania Railroad in Elizabeth, N. J. Ill. (Sc A-Feb. 2.) 500 w.

28947. The History of the Four Wheeled Bogie. Clement E. Stretton (Sc A S-Feb. 2.) 1500 w.

28950. Locomotive Fuel. Editorial (R E M-Feb.) 1200 w.

*28962. An Underground Railway in Paris. Ill. (E-Jan. 25.) 3900 w.

*28980. Transition Curves. Edwin E. Woodman (J A E S-Dec.) 9000 w.

28988. Opposition to Grade Crossings in Connecticut (S R G-Feb. 2.) 1200 w.

†29001. Light Railways and Tramways—Two Letters from the London Standard (I-Eng-Dec. 29.) 1500 w.

†29002. The Madras Electric Tramways (I Eng-Jan. 5.) 2000 w.

*29020. Pop Valve Reminiscences. F. F. Hemenway (L E-Feb.) 3500 w.

*29021. Six and Eight Wheeled Fenders. Ill. W. F. Dixon (L E-Feb.) 2700 w.

*29022. How the Steam Engine Has Been Improved. Editorial (L E-Feb.) 2000 w.

*29023. Where Engineers Hire Their Own Firemen. Editorial (L E-Feb.) 1800 w.

*29024. The Farce of Inspecting Brakes at Terminal Stations—A Reform Needed. Will W. Wood (L E-Feb.) 2000 w.

*29025. Training of Apprentices in Test Department of the Baldwin Locomotive Works. Ill. E. A. Custer (L E-Feb.) 1100 w.

*29028. Plating Department in a Railroad Shop (L E-Feb.) 1300 w.

*29032. Unpunctuality of Railway Trains. Clement E. Stretton (Inv-Jan. 26.) 1100 w.

*29033. The Electric Street Car Brake in America. Editorial (Inv-Jan. 26.) 2200 w.

29034. Ballast. Jerry Sullivan (R R-Feb. 2.) 1400 w.

29036. Piston Travel on Air Brakes Comments on Paper of F. B. Farmer (R R-Feb. 2.) 1200 w.

29087. The Engineers' Plans for a New York Rapid Transit Railway. Editorial (E N-Feb. 7.) 3200 w.

29090. Three-Cylinder Simple Locomotives; Erie and Wyoming Valley Railroad. Ill. (E N-Feb. 7.) 2500 w.

29092. Tests of a Locomotive Using Oil Fuel. Ill. (E N-Feb. 7.) 1100 w.

29110. Timber Preserving Methods and Appliances. Ill. W. G. Curtis (R G-Feb. 8.) 4000 w.

29112. Fuel Saving in Railroads. Editorial (R G-Feb. 8.) 2200 w.

29122. The Electric Railway Developent of Staten Island. Charles H. Cochrane (E E N Y-Feb. 9.) 2500 w.

Serials.

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan., 1894—10 parts to date—15 cts. each).

24586. Railway Companies and Their Employees. O. D. Ashley (R A-Began Aug. 24—8 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R-Began Aug. 25—23 parts to date—15 cts. each).

25670. Special Shop Tools. Ill. (R E M-Began Oct.—5 parts to date—15 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. Ill. A. Flomanche, A. Huberti and A. Stevart (R C J-Began Dec.—2 parts to date—15 cts. each).

28138. Block Signaling. W. H. Elliott (L E-Began Jan.—2 parts to date—30 cts. each).

28304. Signals and Signaling. Ill. (R R-Began Jan. 5—4 parts to date—15 cts. each).

28496. Electric Traction. Philip Dawson (E-Began Jan. 4—3 parts to date—30 cts. each).

28497. Extension and Working of the St. Gothard Railway. Ill. C. S. Du Riche Preller (E-Began Jan. 4—Ended Jan. 18—3 parts—30 cts. each).

28516. Track. (Extract.) L. F. Loree (R R-Began Jan. 12—2 parts to date—15 cts. each).

28632. Light Railways. W. M. Acworth (P Eng-Began Jan. 11—2 parts to date—30 cts. each).

28897. Motor Repairs. Ill. W. E. Shepard (S R J-Began Feb.—1 part to date—45 cts).

29109. The Systematic Improvement of the Lake Shore and Michigan Southern Railway. Benjamin Reece (R G-Began Feb. 8—1 part to date—15 cts).

SCIENTIFIC MISCELLANY

Meteorological Millers.

THE miller's occupation doubtless preceded the mariner's calling in the evolution of industries, yet the use of sails for moving vessels anticipated their use in windmills. The use of sails for either purpose naturally led to a study of weather indications, and, according to a paper by P. J. De Kidder in *Ciel et Terre* (translated and printed in *The Popular Science Monthly* for February), sailors are popularly credited with more than their share of contributions to weather lore. The millers of the windmills are pronounced to be no less sagacious and no less assiduous than sailors in their observations and generalizations of meteorological phenomena, and the way in which the old-fashioned millers of Holland and Flanders observe atmospheric phenomena, as described in this article, is interesting.

"The most intelligent of them observe, according to their own rules, all the changes of the weather. Those of a lesser degree of intelligence are satisfied with noticing the movements of the mills situated farthest in the direction whence the wind comes, and thus regulating the management of their own mills after the example set them by their fellows. These prepossessions of millers concerning the weather should not surprise us, for it is in the line of their direct interest to prognosticate atmospheric changes, and especially to be able to foresee how strong the wind will be, as much for the safety of their mills, which are exposed to all the storms, as in view of keeping on good terms with their customers by properly executing their orders."

The cirrus and cirro-stratus in the southwest as a sign of coming wind delights these millers. They call these clouds "wind trees." "They were as well acquainted with the cirro-cumulus, the alto-stratus, and the cumulus. Proof of this is found in the enigmatical and obscure language of an old miller, who declared he had seen in the sky a shepherd under the shadow of a tree, while the sheep were pasturing in the field.'"

"Besides looking into the nature and meaning of the cirrus and the cirro-cumulus, the miller tried to calculate the force of the wind in distant storms; he observed the direction and velocity of the lower clouds; he estimated at sight the volume and density of the storm clouds; and, if the wind fell off before the rain came, he recollected the old saying, 'A calm comes before a storm.' He especially displays extraordinary vigilance in times of heavy showers. He observes, among other things, if the mills farthest away in the direction of the rain have kept their sails unfolded; if they have, it is a good sign. He scrutinizes the sky at every moment, from the zenith to the horizon; he measures the curvature of the forward part of the precipitation of the storm. The lines of rain or hail that escape from it show him by their length and their approach to the perpendicular how intense the precipitations are. If the lines run obliquely, he is shown the direction of the dominant wind in the squall; in short, no sign indicating the force and direction of the wind passes unperceived by him. He knows likewise that these showers are often accompanied by tempestuous, plunging gusts, which seem to come out of the clouds; and frequently, before the most advanced flecks of the storm-cloud have reached the zenith, the sails of the mill are rolled up around the arms so as to give the squall free passage."

The old miller was the first to discover that "the air is urged on more violently on the right of a squall than on the left." "The storms that passed by on his left, from west-by-southwest to south, never gave him any fear, and he confidently left his sails all unfurled in the wind: but, whenever he was directly threatened with a storm which would pass over his zenith, or which was coming from the right,—that

is, from north-by-northeast to east,—at a distance of less than five kilometers, he foresaw the possibility of a strong blow, and took his measures accordingly. I never knew of a miller who could account for the squalls from his left being less formidable than those from his right. The explanation of the phenomenon was reserved for modern meteorology, which has taught us that squalls and thunder-showers constitute depressions in miniature, or at least weak secondary depressions dependent upon a principal depression and formed under its immediate influence."

By such observations the miller became so good a prognosticator of what the weather would be that he could confidently say to a customer when a grist would be ground, and, in making such an assurance, he was rarely in error.

Deterioration of Ammonia in Refrigerating Machines.

AN article in *The Stationary Engineer* calls attention to a curious condition that takes place after a longer or shorter time in ammonia used in refrigerating machines. This change has been observed both in the absorption and compression systems. Its exact nature does not appear to have been determined. It has caused more trouble in the compression system of refrigeration than in the absorption system, but it seems probable that this is due to the greater extent to which the compression system has gone into general use. After a longer or shorter period of running, air and gases are found to have accumulated in the system, and their presence is a puzzle, since the pressure in all parts of the circulating system is greater than that of the exterior atmosphere, and leakage from the exterior into the interior of the system is thus evidently an impossibility. The fact remains that not only air, but other gases accumulate in quantities sufficient to seriously embarrass working, and a liquid of a yet unknown character also forms, creating a further obstruction.

Theoretically, and practically, only pure, anhydrous ammonia is used in charging compression refrigerating machines, and this, so far as known, is a permanent gas, only liquefiable by the aid of cold and pressure, and rapidly volatilizing again, when pressure is removed. The liquid, therefore, which is spoken of as forming in ammonia refrigerating apparatus is a distinct product. It has the appearance of water, but seems to be of a different nature, "because it does not wet the surface with which it comes in contact, as water does. The nature and source of this substance have not yet been satisfactorily accounted for, and its nature and properties are not known."

The experiment of an engineer in charge of a compression refrigerating plant is quoted, as given by himself in *Ice and Refrigeration*. Having found the interceptor two-thirds full of liquid and the action of the apparatus much below the normal standard, he "turned a hot-water jet on the interceptor to facilitate evaporation, and it took about five hours to reduce the liquid to a point in the interceptor where he judged but three or four gallons remained, calculating by the ice line outside of the interceptor. Concluding that the balance remaining must be very weak, he drew it off and found it to be quite lively while being drawn off, as it sputtered sharply and frosted everything it touched. However, in the empty ice-mould in which he drew it, it remained comparatively dead, and it would not evaporate enough to be noticed. After a few hours he emptied the stuff on the stone floor, when it boiled pretty sharply, and in a few minutes had evaporated, leaving a trace of oil and some water on the floor. He adds: 'I had previously been short of ammonia in the cistern for several weeks, but, after pumping out and blowing off the interceptor, I had all the ammonia I needed. On both occasions I tried to purge the condenser and evaporator lower headers, and found nothing of weak or dead liquor on either side. On one occasion the machine was working at 180 lbs. condensing pressure prior to pumping the vacuum, and on the other occasion at 12 lbs.'" His conclusion was that the liquid, whatever it may prove to be, is something produced from the oil used for lubrication, since this is the only other substance that is used in

the system. There is here an opportunity for some chemist to distinguish himself by the exact determination of what the liquid is, and how it and the gases alluded to are formed, or how they find access into an inclosure in which nothing but anhydrous ammonia and oil are at first contained, and in which a higher pressure than that of the atmosphere is constantly maintained.

Chemical Fire Extinguishing.

NEARLY everybody is now familiar with the class of chemical fire extinguishers which employ carbonic acid for the purpose of putting out fires in their incipient stages. These exist in quite a variety. Some hold liquefied carbonic acid (called by chemists carbon dioxid); others contain the ingredients for generating this gas, which are made to react upon each other when the gas is wanted. Various acids, as sulphuric, tartaric, and oxalic, have been used, while marble dust (calcium carbonate) has been much used as the article from which to obtain the carbon dioxid by the action of the acid reagent upon the carbonate. Such fire extinguishers, together with the mechanical sprinklers that have come into use, have saved many millions of dollars in the United States and in other lands. But there appears to be no such thing as a standstill in any line of modern improvement, and some new things in the way of chemical fire extinguishing and prevention are coming to the front. Some of these are discussed in *Engineering News* (Jan. 24).

"The modern methods of fire protection by chemicals, which bid fair to entirely displace the old, consist in the use of certain salts which, when heated, give off a gas which extinguishes the fire partly by shutting out the supply of air, and partly by the cooling effect produced by the separation of the gas from the salt. For fire-extinguishing purposes the salt is dissolved in water and used either to fill fire pails or portable extinguishers with a hand force pump and hose attachment. An important advantage is that the salt in solution has little or no corrosive effect, and by the mixture of other substances the solution may be made deliquescent, so that it will not dry away when left in the pails. The effect of such a chemical solution in the extinguishing of fires is truly remarkable. Water poured on a fire, as is well known, has little effect except on the part which it actually touches; but the chemical solution gives off at once a gas which rises and envelops all parts, extinguishing the flame as if an invisible blanket were wrapped about the blazing pieces. Of course, when a fire has been burning for some time, and a body of hot coals has accumulated, the heat actually stored up in the coals must be dissipated in some way. The rapid spread of fire occurs, however, by the spread of the flames, and the influence of the chemical solution in checking this is equal to the effect of a volume of water many times as great, with the additional advantage that the gas will rise and check the flame in closed spaces, such as hollow partitions, where water cannot reach. The expense of the chemicals is not great, especially in view of the fact that the necessity for their use is a rare occurrence."

It is further stated that an oil fire may be as readily extinguished as any other, and that the use of the same chemicals enables wood and textiles to be rendered fire-proof. The names of the chemicals are not given, as some of the processes are kept secret. Ammoniacal salts, with, perhaps, some admixture of chlorids, are inferred, but *Engineering News*, which claims to have been several months investigating the merits of the new methods, expresses the conviction "that by this use fire risk and losses may be materially diminished."

Rare Earths of Chemistry.

THE so-called earths are oxids not easily reduced by ordinary methods. They are insoluble in water, and are scarcely or not at all altered in their chemical characteristics by high temperatures, although physical changes in them may be thus produced,—as with clay which from a plastic state is changed to a stony texture by heat. Clay, lime, and magnesia are earths familiar to everyone. The so-called "rare earths" are oxids of the following substances: cerium, lanthanum, thorium,

yttrium, zirconium, didymium, and erbium. According to the *Progressive Age* (Feb. 1), the term "rare" is no longer applicable to these earths, since they are now used largely in the manufacture of mantles for the Welsbach light, the demand for this industrial use having caused them to be sought for and found in considerable quantities. It is asserted that they are now produced by the ton "at a cost not fancy, but commercial."

"Dr. Carl Auer von Welsbach, an Austrian chemist of high standing, has been more active than any one else in the study of the practical applications of these 'rare earths.' The lamp that bears his name is evidence of the fact. Dr. Auer was the first to split didymium; one portion (possibly an element), on account of its giving green salts, he called praseo (green) didymium, the other neo (new) didymium. Didymium, from didymos, twin, was so named because it so closely associated with lanthanum. In this country some research has been made, as is well shown by the following extract from an article on 'Chemistry at the World's Fair,' by Dr. Marcus Benjamin, who was one of the judges in that department. It is found in *The Chautauquan* for December, 1893.

"'These earths are particularly fitted for use in the Welsbach mantles or hoods, possessing in a higher degree than other known substances the property of becoming incandescent at comparatively low temperatures.' Speaking of chemical exhibits at the Chicago Exposition, *The Chautauquan* said that 'perhaps the most remarkable exhibit of chemical interest is that made by Waldron Shapleigh. This chemist was called upon to study certain of the rare earths, especially in their relation to incandescent burners, for which purpose it became necessary for him to separate them on a large scale, and to obtain them in great purity. The researches of chemists abroad had shown that the so-called element didymium was a compound, but it was not until Mr. Shapleigh took the matter up that this fact became a reality beyond doubt. This work corroborated the results obtained by spectroscopic analysis, and the old element yielded place to the newer neo-didymium and praseo-didymium, each of which is represented by a beautiful series of salts, and, curiously enough, each element is characterized by salts of the same color,—that is, one series in pinkish and the other green. Salts of such rare elements as erbium, yttrium, thorium, lanthanum, and cerium are also shown by him.' . . . . Results such as Mr. Shapleigh has obtained would be recognized abroad from one end of the continent to the other." The sources of supply for these substances are now kept secret, but *Progressive Age* intimates that they are likely to be found in quantity in North Carolina and Northern California. Further particulars of the chemical and physical properties of these substances complete the article noticed.

Artificial Gems.

IN line with what was said in this department in February as to the scientific mysteries of the ruby, the *Boston Journal of Commerce* (Feb. 2) prints an interview of a Washington correspondent with Prof. F. W. Clarke relative to the probable manufacture, in the near future, of diamonds of marketable size.

Prof. Clarke, it is stated entertains the belief that this will soon be done. "Moissan, in Paris, has manufactured diamonds by melting wrought iron together with carbon and permitting the mixture to cool very slowly. Under these conditions the carbon became crystallized. Simultaneously Kroustchoff, in St. Petersburg, has got diamond crystals by a similar process, employing silver instead of iron. These artificial diamonds are scarcely big enough to be seen with the naked eye, but they represent the solution of the problem of crystallizing carbon. So much being accomplished, it may be confidently expected that crystals of greater size will soon be produced. It has been argued that in the laboratory the processes of nature can only be imitated on a contemptible scale; but you must remember that crystals of carbon need not be very big in order to possess value as gems."

As to the way diamonds are formed in nature, much speculation has been in-

dulged in, and as yet nothing is certainly known. Upon this point Prof. Clarke thinks some warrant for a shrewd guess can be obtained from facts relating to the great diamond field of South Africa. "There eruptive matter from deep in the earth seems to have burst out through a surface layer of shale, the latter being very rich in carbon. Slow cooling followed, and the carbon was crystallized out, as in the experiments of Moissan and Kroustchoff."

Imperfect garnets have been made artificially. Peridots (crystallized transparent olivine) are also produced. So-called artificial pearls, which are good imitations, but which by no means equal real pearls, have been manufactured for a considerable period. The best of the imitation pearls are beads cut from mother of pearl and coated with silver. The specific gravity of these factitious gems and their luster is about the same as that of gray pearls. The silver coating, however, is not permanent, and, when it wears away, the false character of the gem is fully revealed. Art has never been, and probably never will be, able to rival nature in pearl-making.

The World's Carrying Trade.

FROM a paper in *The Contemporary Review* by Michael Mulhall, the following leading facts relative to the carrying trade of the world are gathered. The people of the British Empire own more than half the ocean vessels of the world, and fifty per cent. of the annual savings of the nation is expended in building new ships and railroads. Since 1840 the tonnage of British shipping has trebled, while that of all other nations has only doubled. Fifty years ago British shipping held one-third the carrying trade of the high seas. To-day it holds over one-half. Sailing vessels have now an aggregate carrying capacity of only one fifth that of steam-vessels. The decline of tonnage of sailing vessels since 1860 has been four million tons. The increase in trade has not fully kept pace with increase of tonnage, which gives color to the assertion made in some quarters that the business of transportation, like other industries, has been developed to a point beyond existing needs. The greatest increase in port-entries is found in the colonies and South America. The tendency in ship-building at present is toward increase of size.

Turning next to the railway carrying trade, we find that there are now in operation 410,000 miles. This would be sufficient to girdle the earth at the equator about sixteen times. The total cost of these railways has been $3,073,400,000,000. Of existing railway mileage 99 per cent. has been built since 1840. Since 1860 the average annual railway construction has been 10,000 miles. Railway traffic has reacted upon marine traffic to largely increase the latter. In 1850 the cost of land carriage was eight times as much as it is in 1895.

While Great Britain holds supremacy in ocean traffic, the United States is far in advance in railway traffic, doing two-thirds of all the railway transportation of goods, and owning one-third of the total railway mileage of the globe.

The navigable waterways of different countries (rivers and canals) are, in miles, as follows: Britain, 3810; France, 7730; Germany, 17,080; Russia, 33,920; Austria, 7200; Canada, 3360; United States, 51,820; Brazil, 22,000. The carrying capacity of vessels navigating lakes and rivers of the United States is 9,300,000 tons. Of the total carrying traffic of the Suez Canal, British vessels do 76 per cent. The net profits of this canal in 1892 amounted to 8.5 per cent. of the cost of its construction.

Turpentine and Its Derivatives.

CRUDE turpentine is a gum which exudes from a number of varieties of pine trees when they are tapped, or when cavities are cut in their trunks. The gum oozes out slowly, and, after a sufficient quantity has issued from the openings, collections are made. Pine trees freshly tapped yield the best quality. The quality deteriorates and the yield gradually diminishes when trees are tapped year after year. Distillation of the crude gum causes it to yield spirits (sometimes called "oil") of turpentine. Quoting the *Commercial Bulletin*, the

Scientific American Supplement describes a process which, though apparently simple, requires care, skill, and judgment for its successful conduct.

"The stills will hold ten, fifteen, twenty, and sometimes forty barrels of gum. This is 'charged' in at the top, and the cap fitted on. This cap connects by an arm with the worm, around which cold water is constantly running. When the still is filled and this connection made, the fire is applied. As the process of distillation goes on, the distiller adds, from time to time, a little water to prevent scorching, and tries his 'charge' by inserting a rod in a small hole in the top of the still, intended for that purpose. When the process has reached a certain point, he draws his fire, and allows the still to cool a little; then he takes off the cap, and from the liquid mass inside skims off the chips and bark, of which there is always more or less in the gum. If the cap is taken off too soon, the whole charge will take fire from rapid oxidation. When the hot resin is cooled down, it is drawn off through a pipe at the side of the still near the bottom, and passes through strainers into a wooden tank, from which it is dipped into barrels. Upon the care taken in straining the resin depends much of its value in the market; hence certain brands made by careful men soon become known and command high prices. The spirits, being condensed in the worm, run out, mingled with considerable water, into a tub, the water, on account of its great specific gravity, settling at the bottom. From this tub the spirits are siphoned off into well-glued barrels for shipment." It is added that a little carelessness may result in a fire which will destroy in a day 2 or 3 years' profits.

Of tar it is said that in the South it is made "by simply arranging an earthy covering over fat, light wood, thus confining the heat within in such a manner that the drops of fat (inflammable substance) exude through the outer covering. Lampblack is made from this crude tar, for marking cotton bales, boxes, etc., and the negroes use it for staining into solemn blackness the home-made coffins, made of hard pieces of boards, in which they bury their dead. A landowner renting his land to the distillers usually charges about $10 a hundred trees for each season, according to the number of boxes he allows cut in each tree." Those who make the distillation of turpentine a business are itinerant, going about to different locations, where they can get trees. They are said not to be in the best repute for honesty.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

28402. America's Relation to the Advance of Science. (Extract.) G. Browne Goode (Sc-Jan. 4) 2500 w.

28403. The Humanities. J. W. Powell (Sc-Jan. 4.) 3000 w.

28411. Engineering Facts vs. Credulity. George V. Wisner (E N-Jan. 10.) 1800 w.

28412. The Cost of Hydrographic Surveys (E N-Jan. 10.) 700 w.

28416. Mond's New Process of Obtaining Chlorine. Ill. (E M J-Jan. 12.) 1300 w.

†28503. On a New Specimen of Cladodus Clarki. Ill. E. W. Claypole (A G-Jan.) 2200 w.

†28504. The Columbia Formation in Northwestern Illinois. Oscar H. Hershey (A G-Jan.) 5700 w.

†28505. The Munuscong Islands. Ill. F. B. Taylor (A G-Jan.) 2500 w.

†28506. The Age of the Galena Limestone. N. H. Winchell (A G-Jan.) 1800 w.

†28507. Acidic Eruptives of Northeastern Maryland. Charles Rollin Keyes (A G-Jan.) 2000 w.

28563.—$1. The Cape York Ironstone. R. E. Peary (B G S-Dec. 31.) 15700 w.

*28637. Engineering Fallacies. Editorial (Eng L-Jan. 11.) 2000 w.

28675. Weight and Mass. De Volson Wood (A M-Jan. 24.) 1500 w.

*28692. Recent Work of Elihu Vedder. Ill. W. C. Brownell (Sc M-Feb.) 2600 w.

28702. Chemical Methods of Preventing and Extinguishing Fires (E N-Jan. 24.) 1200 w.

*28726. Flameless Explosives. Editorial (E-Jan. 18.) 2200 w.

*28733. Science in 1894. (Eng L-Jan. 18.) 2200 w.

We supply copies of these articles. See introductory.

*28735. Acetylene as an Illuminant. Editorial (Eng L-Jan. 18.) 1600 w.

*28748. Artificial Light. (Tr-Jan. 18.) 2200 w.

28783. The Deterioration of Ammonia in Refrigerating Systems. Anon. (S E-Jan.) 1800 w.

†28791. The United States Geological Survey. Charles D. Walcott (P S M-Feb) 9000 w.

†28793. Windmills and Meteorology. P. J. de Ridder (P S M-Feb.) 900 w.

†28794. Science in Education. Editorial (P S M-Feb.) 1400 w.

†28834. An Examination of the Atmosphere of a Large Manufacturing City. Charles F. Mabery (J A C S-Feb.) 4500 w.

*28843. The Outlook for Decorative Art in America. Frank Fowler (F-Feb.) 3700 w.

†28855. Annual Review of Science and Industry. (Abstract of Secretary's Report) (J F I-Feb.) 7000 w.

†28856. On the Relation of Gravity to Continental Elevation. T. C. Mendenhall (A J S-Feb.) 1600 w.

†28857. Observation Upon the Glacial Phenomena of Newfoundland, Labrador, and Southern Greenland. G. Frederick Wright (A J S-Feb.) 3300 w.

†28858. On the Recurrence of Devonian Fossils in Strata of Carboniferous Age. Henry S. Williams (A J S-Feb.) 2800 w.

†28859. Constituents of the Cañon Diablo Meteorite. Orville A. Derby (A J S-Feb.) 2400 w.

†28860. The Inner Gorge Terraces of the Upper Ohio and Beaver Rivers. R. R. Hice (A J S-Feb.) 3000 w.

†28861. The Glacial Land-Forms of the Margins of the Alps. Hugh Robert Mill (A J S-Feb.) 2300 w.

†28863. Lower Cambrian Rocks in Eastern California. Charles D. Wolcott (A J S-Feb) 800 w.

†28864. On the Pithecanthropus Erectus, Dubois, from Java. O. C. Marsh (A J S-Feb.) 1000 w.

28878. Gems Made to Order—Chemists Are Now Making Several Kinds of Precious Stones. (B J C-Feb. 2.) 1000 w.

28946. Professor Lowe's Experience with Balloons. (Sc A-Feb. 2.) 2800 w.

28949. Tar, Pitch and Turpentine. (Sc A S-Feb. 2.) 2200 w.

28956. The "Rare Earths" of Chemistry. Editorial (P A-Feb. 1.) 1600 w.

†28979. On the Influence of Magnetism on Chemical Action. F. A. Wolff, Jr. (A C J-Feb.) 5500 w.

*29017. Some Early Terrestrial Magnetic Discoveries Pertaining to England. L. A. Bauer (N-Jan. 24.) 2700 w.

*29040. Engineers of To-day and Yesterday. I. Edward Millar Gard Eddy. II. James Deas (E Rev-Jan. 21.) 3000 w.

*29049. Presidential Address of E. Hazel. (P Eng-Jan. 25.) 2500 w.

†29080. The Geologic History of Missouri. Arthur Winslow (A G-Feb.) 3000 w.

†29081. Further Observations on the Ventral Structure of Triarthrus. Ill. Charles E. Beecher (A G-Feb.) 3500 w.

29086. Preservative Coatings for Iron Work. A. H. Sabin (E N-Feb. 7.) 3200 w.

29099. Charcoal; Its Bearing on the Utilization of Our Forests. T. J. Drummond (C M R-Jan.) 6000 w.

29101. Mineral Waters. J. T. McCall (C M R-Jan.) 3000 w.

29107. Chimneys and Draft. E. D. Meier (Pr-Feb.) 3000 w.

29134. The Ancient Coinage of China (E M J-Feb. 9.) 900 w.

†29136. Rubber Tires at the New York Cycle Show (I R W-Feb. 10.) 5000 w.

†29137. The Work of the Brazilian Rubber-Tree Tappers. M. F. Sesselberg (I R W-Feb. 10.) 2000 w.

†29138. Hard Rubber Casting Patterns. John T. Usher (I R W-Feb. 10.) 1200 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I-BeganMay—Ended Feb.—10 parts—45 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng-Began Aug. 10—11 parts to date—30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—8 parts to date—15 cts. each).

26906. Statically Indeterminate Structures and the Principle of Least Work. Ill. (E-Began Nov. 9—4 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making (S E-Began Nov.—3 parts to date—15 cts. each).

27548. Constructive Engineering on the Pacific Coast. Ill. (I S F-Began Dec.—3 parts to date—30 cts. each).

28231. The Animal as a Prime Mover. R. H. Thurston (J F I-Began Jan.—2 parts to date—45 cts. each).

28263. The Handling of Men. Foster Crowell (E R-Began Jan. 5—3 parts to date—15 cts. each).

28353. Explosives and Their Modern Development. Vivian B. Lewes (J S A-Began Dec. 28—4 parts to date—30 cts. each).

28427. An American Engineer's Observations in Europe. J. F. Flagg (E R-Began Jan. 12—1 part to date—15 cts).

28838. The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagrations. (Abridged.) Thomas H. Norton (J A C S-Began Feb.—1 part to date—45 cts).

28862. Distribution of the Echinoderms of Northeastern America. A. E. Verrill (A J S-Began Feb.—1 part to date—45 cts).

29082. The Second Lake Algonquin. Frank Bursley Taylor (A G-Began Feb.—1 part to date—45 cts).

We supply copies of these articles. See introductory.

NEW BOOKS OF MONTH

AN ELEMENTARY MANUAL OF CHEMISTRY. By F. H. Storer, Professor of Agricultural Chemistry in Hartford University, and W. B. Lindsay, Professor of General and Analytical Chemistry, in Dickinson College. Being a revision and re-issue of Professor W. R. Nichols's Abridgment of Eliot and Storer's Manual. New York—Cincinnati—Chicago: American Book Co. [453 pp., 7½″ × 5″, cloth. Price, $1.20.]

THE original edition of this work was published in 1872. Two other editions have since been published, the last previous edition being in 1880. The work having proved by extensive use in the class-room a good text-book for elementary instruction, it is now brought up to date by a thorough revision. The work is, as indicated, an abridgment of Eliot and Storer's Manual, the task of abridgment having been done by the late Professor W. R. Nichols. One of the characteristic and most meritorious features of the treatise is the fact that it is written with a view to make the student rely upon his own experimental work in the laboratory in gaining his acquaintance with the fundamental and main facts of chemistry rather than upon class recitations. To this end experiments have been carefully selected, within the capacity of the students, and as carefully and minutely described, with illustrations of apparatus, &c., in order to surely guide the student in his experimental study. Every fact stated in the book is illustrated by some laboratory experiment of this kind. The authors explain in the preface that the book is not written in the interest of any particular theory, or of any one system of nomenclature or notation, and that their intention is to exhibit, so far as possible, within the limits proper to an elementary manual, the present state of chemical science and the relations of chemistry to its practical applications.

CITY ROADS AND PAVEMENTS, SUITED TO OSWEGO, New York. By William Pierson Judson, M. Am. Soc. C. E., M. Inst C. E. Oswego, New York: R. J. Oliphant, Printer, 1894. [Oct., 60 pp., flexible covers, and cloth.]

ALTHOUGH a great many books have been written upon the subject of pavements and road maintenance, this little book will have a place among the literature of road-making from the fact that it treats of roads specially adapted to towns of about the size of Oswego,—that is to say, containing about 25,000 inhabitants. It discusses the various methods which may and will be proposed for such towns, and the reasons why some are to be avoided and some are to be accepted and used. The author thinks that towns of this kind, contemplating the construction of streets, should profit by the costly experiences of others so far as applicable, and thus avoid building apparently cheap roads, whose repairs will afterwards make them cost more than those originally the most costly, or else costly ones which are not adapted to local needs or means. The whole discussion is based upon general reports and results culled from statistics of seventy-five cities, together with the recently-published floating literature upon the subject, written by experienced engineers and published in the technical journals. The book cannot fail to be of value to many municipal engineers and bodies of municipal officials.

INJECTORS, THEIR THEORY, CONSTRUCTION, AND WORKING. By W. W. F. Pullen, Assistant Lecturer and Demonstrator in Engineering at the University College of South Wales and Monmouthshire, Cardiff. With upwards of 100 illustrations. Manchester, England: The Technical Publishing Co., Ltd., 1893. [188 pp., 7″×4½″.]

PERHAPS no other device used in steam engineering has a more meagre literature than injectors. This is the first instance, so far as we are aware, where an entire treatise has been devoted to the subject; and, lest the reader should suppose that the subject is not commensurate with the effort, it ought to be stated that all sorts of ejectors and injectors are included in the discussion. Thus, air injectors, blast-pipe connections, vacuum-brake ejectors, liquid-fuel inject-

ors, steam injectors, injectors for live steam and for compound live steam, compound exhaust steam, lifting and non-lifting injectors, ejector condensers, re-starting injectors, and water lifters or jet pumps are only a few of the topics named and treated. The theory of the injector is discussed practically, scientifically, and mathematically. It is shown that the action of the injector may be calculated with extreme nicety, and that its action involves the grand principle of the conservation of energy. Upon this is built up the mathematical and scientific theory of its operation. Many engravings and diagrams illustrate the work, and tables for facilitating operations are presented.

PROBLEMS IN MACHINE DESIGN. BY CHARLES H. INNES, M. A., Engineering Lecturer at the Rutherford College, Newcastle-on-Tyne. Manchester: The Technical Publishing Co., Ltd., 1894. [187 pp., 7"×4½", cloth.]

THE author explains in the preface that his object in writing this book is to supply engineering students preparing for the Honor Stages of the science and art and technological examinations in machine construction and mechanical engineering, not merely with a collection of formulæ whose use is but little explained, but with a text-book containing examples showing how such formulæ may be applied to the solution of problems in machine design. Extensive use has been made of the writings of Professor Dwelshauvers-Déry in the chapter on Governors and of the writings of Mr. Young in the chapter on Springs. The publishers mention as a reason why this book should be published that in the report of the examiners of the science and art department in machine construction for the year 1892 some complimentary remarks were made as to the instruction given by the author to his Honors Stage Class.

JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY. 5th Year. New York: The W. J. Johnston Co., Ltd., 1894. [8vo., 760 pp., cloth. Price $5.00.]

PROBABLY none of the numerous annuals issued from the American Press are of greater utility than carefully-prepared and accurate trade directories. In many business houses the information afforded by these books is in constant request, and they are more or less valued, according to their accuracy and convenience for use. But the difficulties in securing absolute accuracy are so great that perfection can hardly be expected. Some errors will usually creep in unavoidably, and, therefore, the value of directories must be relative and comparative. The rapid growth and immense importance of the electric street-railway industries renders a directory of this kind a *sine qua non* to all commercial houses whose business is directly or indirectly connected therewith; and in this directory everything is so well classified, printed in such clear type, and arranged in so judicious a manner, that it may be consulted with the minimum expenditure of time. While the publishers do not claim that they have entirely avoided mistakes, they are evidently entitled to claim that this book is as reliable as could possibly be expected in lines of business wherein so many changes and extensions are constantly in progress. Names of managers, purchasing agents, owners, and, in short, all officials about whom information is likely to be desired, are given, together with a large amount of other statistical information relating to electrical and street railways.

THE CENTRIFUGAL PUMP, TURBINES AND WATER MOTORS, including the theory and practice o hydraulics. Specially adapted for engineers. By Charles H. Innes, M. A., Lecturer on Engineering at the Rutherford College, Newcastle-on-Tyne. With upwards of 130 illustrations. Manchester: The Technical Publishing Co., Ltd., 1893. [178 pp., 7"×4½".]

THE author first deals with general hydraulic principles, and next takes up the discussion of pressure engines producing rotary motion. A third part is devoted to the discussion of turbines, whose power is obtained by altering the direction of motion and velocity of the water. A fourth part treats of the centrifugal pump, and the discussion is concluded by the consideration of the subject of hydraulic buffer stops. The assumption is made that the reader is prepared by a sufficient knowledge of statics, dynamics, and hydrostatics to deal with the mathematical equations necessary to the full exposition of the action of these machines. Frictional resistance and losses are expressed in sim-

ple mathematical form. These formerly presented difficulties, but their thorough theoretical and practical investigation has now so far removed the difficulties as to make passive resistances amenable to computation. The use of the elements of trigonometry in the attempt to master the subject of hydraulics is strongly advised. The whole forms a trustworthy addition to the literature of pumps, turbines, and water motors.

STREET-RAILWAY INVESTMENTS. A STUDY IN VALUES. By Edward E. Higgins. New York: The Street Railway Publishing Co., 1895. [8vo., 102 pp., cloth. Price $2.00.]

IN the preparation of this volume, which is mainly statistical, Mr. Higgins considers the street-railway securities in existence at the present time to represent, first, the purchase or valuation of the old horse-railway properties at a large advance on their original costs; second, the reconstruction and re-equipment of such properties accompanying the change of motor power at a cost usually in excess of that for which the same or superior work could now be done; third, the extension of the re-organized properties into the new territory; fourth, the development of entirely new properties in unoccupied territory; and, fifth, construction, promotion, and banking and brokerage profits. He presents questions which at present are creating some uneasiness in the public mind, and which are suggested by almost universal overcapitalization of costs and, in some instances, overcapitalization of earning power. He asks: "Will the growing confidence in street-railway investments be justified by results? Is the rapid development normal? Is it not a repetition on a smaller scale of the steam railway 'boom' of 1869-73, and will not disaster come?" He regards these questions as at present incapable of being answered wisely, and considers the present situation as one of fundamental changes, whose effect cannot now be estimated or predicted. He thinks, however, that it is not impossible even now to lay down certain principles which will serve to determine the limits of success in particular cases, and to establish broad lines of a "theory of values in in this comparatively unknown financial field." A classification of surface railways in American cities and towns is based upon the number of inhabitants in the respective cities, and interurban electric railways are considered in a class by themselves. The treatise is full of valuable detailed information relating to cost and operation of roads in all parts of the United States. A further classification is made of systems in relation to the passenger income per capita per annum, and from this standpoint the author enters upon a very interesting and elaborate discussion of systems in groups, in which the passenger income lying between the same limits is worked out. In a pocket inside the cover is folded a removable sheet, 47″ × 16″, on which are printed two voluminous tables, one of which comprises statistics of capitalization, and the other statistics of operation of American street-railway systems. The amount of labor this represents may be comprehended when it is stated that these statistics have been compiled in the most exhaustive and thorough manner for no less than 145 different street-railway systems. These two tables are alone worth the price of the book.

THE SLIDE RULE. A PRACTICAL MANUAL. By CHARLES N. Pickworth, Whitworth Scholar, Member of the Manchester Association of Engineers, &c., &c. Manchester: Emmot & Co., Ltd. New York: D. Van Nostrand Co., 1894. [56 pp. 5″ × 7″, flexible covers. Price 80 cents.]

THE use of the slide rule in drawing-rooms and engineers' offices is constantly increasing, as the labor-saving capacity of the instrument in making practical computations becomes more widely known and appreciated. Mr. Pickworth's book is intended to give practical examples and explanations of the use of the slide rule, so arranged as to form a practical course of instruction. Various slide rules are described, and the proper sizes for special uses are discussed. The mechanical principle and the mathematical principle involved in the notation are made plain to the understanding; and then a set of operations which cover the whole capacity of the instrument are successively presented.

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MARCH 1895 Vol. VIII. No. 6

The Engineering Magazine

AN INDUSTRIAL REVIEW

EDITED BY JOHN R. DUNLAP.

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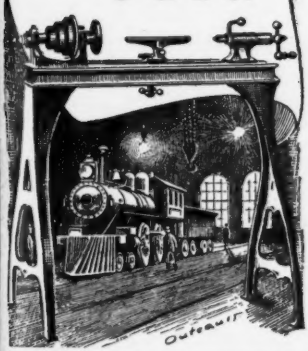

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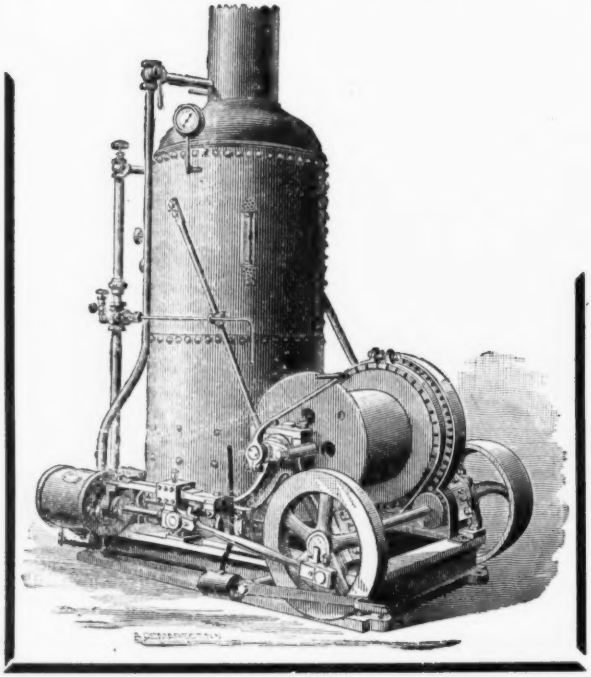

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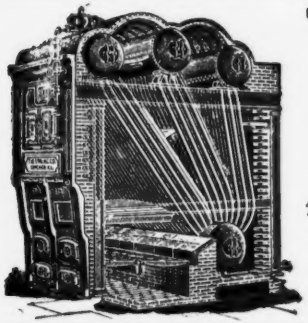

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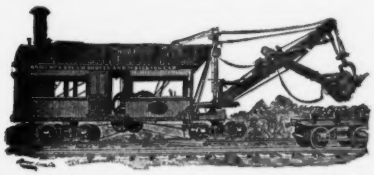

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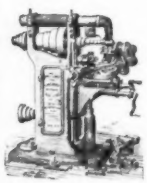

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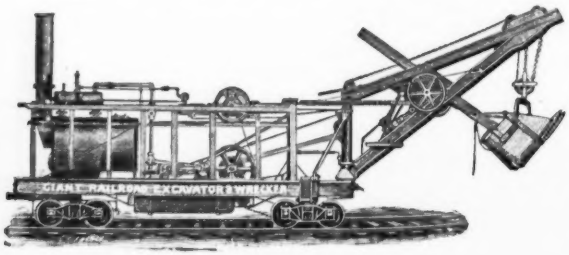

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See next issue of this magazine.

A WORD OF INTRODUCTION.

Authors and Papers This Month.

W. H. CANNIFF (*The Relation of Railways to their Employees*)—Born Oct. 22d, 1847, at Litchfield, Mich.; entered railway service in 1863, since which time he has continuously held various positions in connection with railways in all branches of the service up to and including his appointment as General Superintendent of the Lake Shore & Michigan Ry. Co., Jan'y 1st, 1892, which position he now occupies.

CY. WARMAN (*Relations of the Employee to the Railroad*)—Born in Denver, Colorado; in earlier days engineer on the Denver and Rio Grande Railway; at one time edited a railroad paper in Denver; his poetic genius was recognized from the first by Mr. Dana of the New York *Sun*, to which paper he has supplied numerous poetical contributions; has travelled extensively in Egypt and the Holy Land; at present in England for the purpose of studying English railway methods, after which he will visit France to study French railway methods; some of his journalistic work has attracted wide attention, notably his description of a run from New York to Chicago on the fastest long-distance train of the world.

BARR FERREE (*Recent Architecture in France*)—Honorary corresponding member of the Royal Institute of British Architects; Membre Correspondant de l'Académie d'Aix-en-Provence; Membre de la Société de l'Histoire de France, Paris; Member of the Council of the American Society of Church History; Member of the Advisory Board of the Department of Architecture, Brooklyn Institute; 1892-1894 editor of the department of Architecture in THE ENGINEERING MAGAZINE; a frequent contributor to the leading magazines and technical papers on architectural subjects; "Mr. Barr Ferree, of New York, has been elected an honarary corresponding member of the Royal Institute of British Architects – a compliment paid hitherto to only four other Americans. Two of these are Mr. Richard M. Hunt, who was also the gold medallist of the Institute in 1893, and Prof. William R. Ware, of Columbia College. The Royal Institute sustains the same relation to the profession in Great Britain – only in a higher and more important degree – that the American Institute of Architects does on this side of the Atlantic. Mr. Ferree, who has become one of the leading architectural writers of the time, had previously been elected to honorary membership in the Academie d'Aix-en-Provence, an important architectural society in France. Neither of the societies named had previously paid such a tribute to any American writer."—*The World*.

RUDOLPH HERING (*Sewers and Sewage Disposal*)—Born in Philadelphia, Pa.; educated in Dresden, Germany, 1860 to 1867, graduating from the Royal Saxon Polytechnic College as Civil Engineer; commenced practice as rodman in Prospect Park, Brooklyn, then being constructed; subsequently assistant engineer in charge of construction of Fairmount Park, Philadelphia; joined U. S. Geological Survey in 1872; exploring and mapping Yellowstone National Park; in 1873, resident engineer in charge of Girard Ave. (Phila.) Bridge, then the largest roadway bridge in America; assistant engineer in engineering department of the City of Philadelphia, in charge of bridges and sewers, leaving this position in 1880, under commission by the United States National Board of Health to investigate the character and success of the European sewerage works; results of this investigation published in Annual Report of the board for 1881; commenced practice in New York City as civil and sanitary engineer in 1882; in 1883–1886 made extensive surveys and investigations for future water supply of Philadelphia; Chief Engineer of Water Supply and Drainage Commission 1886; Commissioner of Public Works and made report on Sewerage improvements for New York City in 1887; Chairman of Board of Engineers appointed by President Harrison in 1889, for City of Washington; a consulting engineer and designer of wide fame, and an author of many essays, accepted everywhere as authoritative.

(*Continued next page.*)

MAJOR JAMES WAITE HOWARD (*Pavements, Sidewalks, Roads and Bridges.*)= Born at West Point, N. Y., shortly before the civil war; his father was then instructor in mathematics in West Point Military Academy, of which he has since taken the charge; graduated in classical course at Phillips Academy, Andover, Mass.; commenced practical work in railroad construction and tunneling on West Shore Railroad; subsequently finished a course of study in France; next took a course in higher mathematics and physics at the University of Göttingen, Germany; afterwards took a course of study at, and graduated as civil engineer from, Renssalaer Polytechnic Institute, Troy, N. Y.; in 1881–4 visited European cities of importance, studying features of their municipal engineering, extending his travels to Spain, Egypt and Turkey; has made a specialty of municipal engineering, and writes with authority on all topics connected therewith; at present practicing his profession in New York city; has served in the National Guard of several states, and at present holds the commission of Major in the National Guard of New Jersey, of which state he is a resident; member of a number of scientific societies.

F. E. CABOT (*Electric Wiring and the Fire Hazard*)=Born at Boston, Mass., 1859; graduate of Harvard College in class of 1880, where he paid particular attention to electrical physics; in the employ of the local telephone exchanges about Boston, and of the N. E. Weston Electric Light Co. from July 1880 to February 1883, when he entered the employ of the Boston Fire Underwriters Union as electrical inspector; since that time he has been engaged in insurance inspection in Boston and Buffalo, N. Y., and has been for the past three years Supt. of the survey and electrical departments of the Boston Board of Fire Underwriters; member of the committee of the National Electric Light Association which drew the first rules of that body for the installation of electric wires for lights and power; member of the committee of that body at the Cape May Convention, and was represented by proxy on the committee at the Montreal Convention; has been a member and chairman of the electrical committee of the Underwriters' National Electrical Association since its formation three years ago, and is chairman of the committee on testing of that Association; has been associated with Mr. C. J. H. Woodbury in various tests connected with insurance matters.

COVINGTON JOHNSON (*Mine Management and Superintendence*)=Born in Kentucky, 1851; entered University of New York; 1879, assayer and superintendent of Paradise Valley mine, Nevada; 1880, assayer and assistant superintendent Harshaw mine, Arizona; 1881, superintendent of the same; 1882, superintendent of Minas Pratas mine, Sonora, Mexico; 1884, Manager Anglo-Mexican Mining Co., Las Vedras Sinaloa, Mexico; 1889, examining and reporting on mines; now in practice at San Francisco.

CHARLES B. GOING (*Causes of Floods in Western Rivers*)=Born Westchester, N. Y., 1863; graduated Columbia College School of Mines 1882, going direct to Cincinnati as chemist to Commercial Mfg. Co.; shortly afterward, associated with J. B. Porter, established a chemical and physical testing laboratory in Cincinnati, acting as expert to various corporations, Railroad and Municipal boards; since 1889, president and general manager of a corporation interested in property and to some extent in transportation on the Ohio River; also, since 1892, trustee and secretary of the board of trustees of the Glendale (Ohio) water works, and actively interested in construction and operation of the system; an occasional contributor to the literary and technical magazines and journals.

H. L. ARNOLD (*The Conquest of Steel Over Cast Iron*)=Born near Rochester, N. Y., June 25, 1837; worked as a journeyman machinist in western river and lake engine shops and R. I. R. R. shops for twelve years; subsequently superintendent Ottawa Machine Shops and Foundry, Ottawa, Ill., designer and department foreman for E. W. Bliss, Brooklyn, N. Y., superintendent for Stiles and Parker Press Company, Middletown, Conn., and designer for Pratt and Whitney Company, Hartford, Conn.; a frequent, able, and acceptable contributor to *American Machinist*, and other American publications devoted to mechanics.

A. F. McKISSICK (*Electric Power in Southern Cotton Mills*)=Born June 10, 1869, at Union, S. C.; graduated South Carolina University, Columbia, S. C., 1889; manager Congaree Gas and Electric Co., Columbia, S. C., 1889-1890; took graduate course in electrical engineering at Cornell University; worked in factories of Westinghouse Electric Co. and Baxter Electric Motor Co.; elected Professor of Electrical Engineering at the Alabama Polytechnic Institute, Auburn, Ala., and in connection with his work has served as Electrician for the Southeastern Tariff Association and consulting Electrical Engineer for the Pelzer Manufacturing Co.; now Professor of Electrical Engineering in Alabama Polytechnic Institute.

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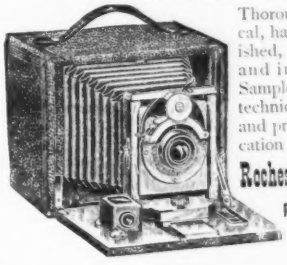

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[SEAL.] (Signed) P. J. SCULLY,

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Building Materials.

Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
E. B. Moore & Co., Chicago, Ill.
Harrison Bros & Co., Philadelphia, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.
Joseph Dixon Crucible Co., Jersey City, N. J.
Empire Fire-Proofing Co., Pittsburgh, Pa.
Samuel H. French, & Co., Philadelphia, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.
Sternbergh & Son, Reading, Penna.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Jas. G. Wilson, 74 W. 23d St., N. Y.
Winslow Bros. Co., Chicago, Ill.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.
Walker Manufacturing Co., Cleveland, Ohio

Cables, Electric and Submarine.

Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.

L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Cameras.

Eastman Kodak Co., Rochester, N. Y.
Rochester Optical Co., Rochester, N. Y.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Carbons for Diamond Drills.

S. D. Dessau, 4 and 6 John St., N. Y.

Carpenters' Tools.

Bridgeport Gun Implement Co., 313 Broadway, N. Y.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
E. L. Deane, Holyoke, Mass.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Ohio Pipe Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Pratt & Letchworth, Buffalo, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.

Chemical Works Machinery.

Fraser & Chalmers, Chicago, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Clay Working Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Clutches, Friction.

Volney W. Mason & Co., Providence, R. I.
Moore & White Co., Philadelphia, Pa.
J. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.

A. J. Beckley & Co., Meriden, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Beckett Foundry and Machine Co., Arlington, N. J.
Gates Iron Works, Chicago, Ill.
Geo. T. McLauthlin & Co., Boston, Mass.
Sturtevant Mill Co., Boston Mass.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.

Contractors' Supplies.

Thomas Carlin's Sons, Allegheny, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Brown Hoisting and Conveying Machine Co., Cleveland, O.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Link Belt Engineering Co., Phila., Pa.
Pennsylvania Machine Co., Philadelphia, Pa.

Corliss Engines.

Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
James A. Miller & Bro., Chicago, Ill.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting and Conveying Machine Co., Cleveland, O.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate Rock.

American Road Machine Co., Kennett Square, Pa.
Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.

Damper Regulators.

Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Desks.

A. H. Andrews & Co., Chicago, Ill.

Diamond Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
E. L. Deane, Holyoke, Mass.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Dredging Machines.

J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

W. F. & J. Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Waterman Machine Tool Co., Oakland, Me.

Drop Presses.

Merrill Bros., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Oh
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.

Dynamos.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

General Electric Co., 44 Broad St., N. Y.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.

Bristol Co., Waterbury, Conn.
Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Queen & Co., Inc., Philadelphia, Pa.
Standard Thermometer Co., Peabody, Mass.
United Electric Telephone Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electrical Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., N. Y.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
Newton Rubber Works, Boston, Mass.
Spinney, Virtue & Co., Lynn, Mass.

Elevators, Steam, Hydraulic, Electric.

M. J. O'Donnell & Co., Cleveland, Ohio.
Morse, Williams & Co., Philadelphia, Pa.
Springfield Foundry Co., Springfield, Mass.

Emery Wheels.

Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Pennsylvania Machine Co., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.

Emery Wheel Machinery.

Pennsylvania Machine Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.

Engineering Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
Wm. E. Stieren, Pittsburg, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
P. H. & F. M. Roots Co., Connersville, Ind.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petroleum

Otto Gas Engine Works, Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Shipman Engine Co., Boston, Mass.

Engines, Portable.

Griffith & Wedge Co., Zanesville, Ohio.

Engines, Stationary.

Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Shipman Engine Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Robert Wetherill & Co., Chester, Penn.

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.
Goubert Mfg. Co., 14 & 16 Church St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Filters.

Continental Filter Co., 44 Wall St., N. Y.

Fire Arms.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Fireproof Building Material.

Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio
Empire Fire Proofing Co., Pittsburgh, Pa.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.
Henry Maurer & Son, 420 E. 23d St., N. Y.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
Pioneer Fireproof Construction Co., Chicago Ill.
Sternbergh & Son, Reading, Penna.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Jas. G. Wilson, 74 W. 23d St., N. Y.
Winslow Bros. Co. Chicago, Ill.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill,
Robert Poole & Son Co., Baltimore, M
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.

Toledo Machine & Tool Co., Toledo, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.

Forgings.

Sternbergh & Son, Reading, Penna.
Toledo Machine & Tool Co., Toledo, Ohio.

Furnace Builders.

Fraser & Chalmers, Chicago, Ill,
Griffith & Wedge Co., Zanesville, Ohio.
Julian Kennedy, Pittsburgh, Pa.

Furniture.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure.

Bristol Co., Waterbury, Conn.

Gages, Steam.

Crosby Steam Gage and Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
Standard Thermometer Co., Peabody, Mass.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Pancoast & Rogers, 22 Platt St., New York.

Gear Cutters.

Pennsylvania Machine Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates and Hearths.

Samuel H. French & Co., Philadelphia, Pa.
Edwin A. Jackson & Bro., 50 Beekman St., N.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach Co., New Bedford, Mass.
New Process Twist Drill Co., Taunton, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y,
Tanite Co., Stroudsburg, Pa.

Grips, Cable Railways

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hangers.

SEE PULLEYS, ETC.

Hardwood Floors.

E. B. Moore & Co., Chicago, Ill.

Hardware Manufacturers.

Charles H. Besly & Co., Chicago, Ill.
Merrill Bros., Brooklyn, N. Y.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
Huvett & Smith Mfg Co., Detroit, Mich.
P. H. & F. M. Roots Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Boynton Furnace Co., 207 Water St., New York.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y
United States Heater Co., Detroit, Mich.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting and Conveying Machine Co., Cleveland, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Volney W. Mason & Co., Providence, R. I
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.

Hod Hoisting Machinery.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.

Hose, Steam and Fire.

Cornelius Callahan, Canton Junction, Mass.
Crosby Steam Gage and Valve Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.

Hydraulic Machinery.

Fraser & Chalmers, Chicago, Ill.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Crosby Steam Gage and Valve Co., Boston, Mass.
Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

O. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire

W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
Merchant & Co., Philadelphia, Pa.
The Okonite Co., Limited, 13 Park Row, N. Y.

Iron Working Machinery.

Charles H. Besly & Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Billings & Spencer Co., Hartford, Conn.
Bradford Mill Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Merrill Bros., Brooklyn, N. Y.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Springfield Machine Tool Co., Springfield, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Oakland, Me.
D. E. Whiton Machine Co., New London, Conn.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.

Lamps, Electric.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Springfield Machine Tool Co., Springfield, Ohio.

Lead Corroders.

Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
Thomas Carlin's Sons, Allegheny, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 115 Broadway, N. Y.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Lunkenheimer Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Armstrong Bros. Tool Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Charles H. Besly & Co., Chicago Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Egan Co., Cincinnati, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
New Process Twist Drill Co., Taunton, Mass.
Robert Poole & Son Co., Baltimore, Md.
Merrill Bros., Brooklyn, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Q. & C. Co., Chicago, Ill.
G. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Springfield Machine & Tool Co., Springfield, Ohio.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Oakland, Me.
D. E. Whiton Machine Co., New London, Conn.

Mantels.

Samuel H. French & Co., Philadelphia, Pa.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
E. L. Deane, Holyoke, Mass.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Merchant Steel.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Meters, Electric.

General Electric Co., 44 Broad St., N. Y.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.

Cincinnati Milling Machine Co., Cincinnati, Ohio.

Mining Machinery.

Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Mining Screens.

Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Mortar Colors.

Samuel H. French & Co., Philadelphia, Pa.

Motors, Electric.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Standard Thermometer Co., Peabody, Mass.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg Co., Pittsburgh, Pa.

Oil Cups.

Lunkenheimer Co., Cincinnati, Ohio.
Wm. Powell Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.

Winslow Bros. Co., Chicago, Ill.

Packing

Home Rubber Co., Trenton, N. J.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.
Quaker City Rubber Works, Philadelphia, Pa.

Paints.

Joseph Dixon Crucible Co., Jersey City, N. J.
Samuel H. French & Co., Philadelphia, Pa.
Harrison Bros. & Co., Philadelphia, Pa.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.
Tanite Co., Stroudsburg, Pa.

Paints (Special for Iron.)

SAME AS ABOVE.

Paper Mill Machinery.

Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Moore & White Co., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
Root, Wetherill & Co., Chester, Pa.

Penstocks.

Atlantic Works, East Boston, Mass.

Perforated Metal.

A. J. Beckley & Co., Meriden, Conn.
Fraser & Chalmers, Chicago, Ill.
Merchant & Co., Philadelphia, Pa.

Photographic Supplies.

Eastman Kodak Co., Rochester, N. Y.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pipe and Boiler Coverings.

H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.
Keasbey & Mattison Co., Ambler, Penn.

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Pancoast & Rogers, 22 Platt St., New York.

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Addyston Pipe & Steel Co., Cincinnati, Ohio.
Ohio Pipe Co., Columbus, Ohio.
Pancoast & Rogers, 22 Platt St., New York.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

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National Pipe Bending Co., New Haven, Conn.

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Armstrong Mfg. Co., Bridgeport, Conn
Pennsylvania Machine Co., Philadelphia, Pa.

Pipe-Spiral Riveted.

Merchant & Co., Philadelphia, Pa.

Pipe, Sewer.

Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.

Morris, Tasker & Co., Philadelphia Pa.
Pancoast & Rogers, 22 Platt St., New York.

Planing Mill Machinery.

Egan Co., Cincinnati, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.

Plaster Ornaments.

Samuel H. French & Co., Philadelphia, Pa.

Portable Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.

Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Power Transmission, Electric.

General Electric Co., 44 Broad St., N. Y.

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Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

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Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass

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M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

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W. F. & J. Barnes Co., Rockford, Ill.

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Cooke & Co., 163 Washington St., N. Y.
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Fishkill Landing Machine Co., Fishkill, N. Y.
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Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

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Fraser & Chalmers, Chicago, Ill.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.

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M. T. Davidson, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

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Mason Regulator Co., Boston, Mass.

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Long & Allstatter Co., Hamilton, Ohio.
Springfield Machine Tool Co., Springfield, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio,
Walker Manufacturing Co., Cleveland, Ohio.

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Vulcan Iron Works, Toledo, Ohio.

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The Okonite Co., Limited, 13 Park Row, N. Y.

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General Electric Co., 44 Broad St., N. Y.

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Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
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American Road Machine Co., Kennett Square, Pa.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa.
O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
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Griffith & Wedge Co., Zanesville, Ohio.
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Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Rolling Mill Machinery.

Long & Allstatter Co., Hamilton, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Rolling Shutters, Partitions, Etc.

Jas. G. Wilson, 74 W. 23d St., N. Y.

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Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
Merchant & Co., Philadelphia, Pa.
James A. Miller & Bro., Chicago, Ill.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.

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Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.

Rope Transmission.

Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Link-Belt Engineering Co., Nicetown, Phila.

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Newton Rubber Works, Boston, Mass.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.
Spinney, Virtue & Co., Lynn, Mass.

Safety Valves.

Crosby Steam Gage and Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.

Saw Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Egan Co., Cincinnati, Ohio.
Griffith & Wedge Co., Zanesville, Ohio.

Scrapers, Wheel and Drag.

American Road Machine Co., Kennett Square, Pa.

Screens, Mining.

A. J. Beckley & Co., Meriden, Conn.
Fraser & Chalmers, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Screw Machines.

Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.

Separators, Coal and Ore.

F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.

Separators, Steam.

The Goubert Mfg. Co., 14 & 16 Church St., N. Y.

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Union Sewer Pipe Co., Akron, Ohio,

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Toledo Machine & Tool Co., Toledo, Ohio.

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Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Skylights.

Canton Steel Roofing Co., Canton, Ohio.

Skylights (Sheet Metal).

James A. Miller & Bro., Chicago, Ill.

Steam Regulating Appliances.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator Co., Boston, Mass.
Penberthy Injector Co., Detroit, Mich.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
Reliance Gauge Co., Cleveland, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.
Standard Thermometer Co., Peabody, Mass.

Steamships and Tow Boats.

Atlantic Works, East Boston, Mass.

Steam Shovels.

Thomas Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Steam Traps.

Buffalo Forge Co., Buffalo, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
The Goubert Mfg. Co., 14 & 16 Church St., N. Y.

Steel Importers.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Merchant & Co., Philadelphia, Pa.

Steel Manufacturers.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Pennsylvania Steel Co., Steelton, Pa.

Steel, Tool.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.

Structural Iron Work.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.

Surveying Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N.
Queen & Co., Philadelphia, Pa.
Wm. E. Stieren, Pittsburg, Pa.

Tanks, Iron.

Continental Iron Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

Telegraph Wires and Cables.

General Electric Co., 44 Broad St., N. Y.
Eastern Electric Cable Co., Boston, Mass.
John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Telephones.

United Electric Telephone Co., Chicago, Ill.

Temperature Regulators.

Standard Thermometer Co., Peabody, Mass.

Testing Machinery.

Wm. Sellers & Co., Philadelphia, Pa.

Thermometers.

Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
Queen & Co., Inc., Philadelphia, Pa.
Standard Thermometer Co., Peabody, Mass.

Tiles.

Samuel H. French & Co., Philadelphia, Pa.

Tin Plate Rolling Machinery.

Robert Poole & Son Co., Baltimore, Md.

Tin Plates.

Merchant & Co., Philadelphia, Pa.

Track Bolts.

Sternbergh & Son, Reading, Penna.

Tramways.

Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Tramways, Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Fraser & Chalmers, Chicago, Ill,
Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway, N. Y.

Transmission Machinery.

Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

Tube Scrapers.

Sherwood Mfg. Co., Buffalo, N. Y.

Turbines.

Dayton Globe Iron Works, Dayton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood, & Co., Philadelphia, Pa.

Turn Tables.

Wm. Sellers & Co., Philadelphia, Pa.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
New Process Twist Drill Co., Taunton, Mass.

Vacuum Pumps.

A. S. Cameron, Steam Pump Works, E. 23d St., N. Y.
Clayton Air Compressor Works, 26 Cortlandt St. N. Y.
Deane Steam Pump Co., Holyoke, Mass.

Valves, Gas, Steam and Water.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Home Rubber Co., Trenton, N. J.
Lunkenheimer Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.
Mason Regulator Co., Boston, Mass.
Pancoast & Rogers, 22 Platt St., New York.
Standard Thermometer Co., Peabody, Mass.

Ventilating Appliances.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Globe Ventilator Co., Troy, N. Y.
P. H. & F. M. Roots Co., Connersville, Ind.

Voltmeters.

General Electric Co., 44 Broad St., N. Y.
Weston Electrical Ins. Co., Newark, N. J.

Water Works Supplies.

American Waterworks Supply Co., 26 Cortlandt St., N. Y.

Water Wheels.

Dayton Globe Iron Works, Dayton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood & Co., Philadelphia, Pa.

White Lead.

Samuel H. French & Co., Philadelphia, Pa.
Harrison Bros. & Co., Philadelphia, Pa.

Wire.

Charles H. Besly & Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Fraser & Chalmers, Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wood Carpets, etc.

E. B. Moore & Co., Chicago, Ill.
Jas. G. Wilson, 74 W. 23d St., N. Y.

Wood Stains.

Harrison Bros. & Co., Philadelphia, Pa.

Wood-Working Machinery.

Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

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A Classification of the Professional Cards Appearing Regularly in the Pages of the Engineering Magazine.

As a medium for professional announcements these pages offer the superlative merit of reaching, not only engineers, architects, electricians, and railway managers, but beyond these thousands of non-technical business men actively engaged in every field of industrial enterprise, and who constantly require the assistance of professional experts. In a word, we place the engineer or architect, not only before his fellow experts, but also before the men who are his possible clients. In this essential particular the magazine offers an advantage which is superior to anything else available to the practitioner; and in recognition of this fact we have fixed a special and very low rate for professional cards with a view to establishing this Directory as a recognized medium for reference Particulars on application.

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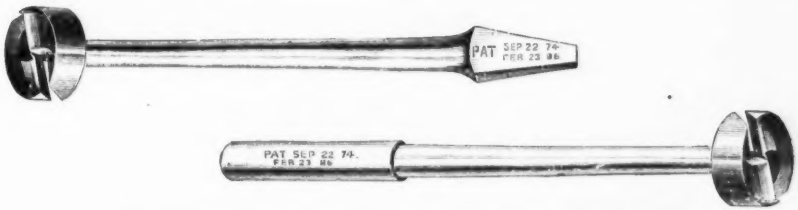

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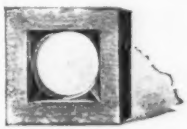

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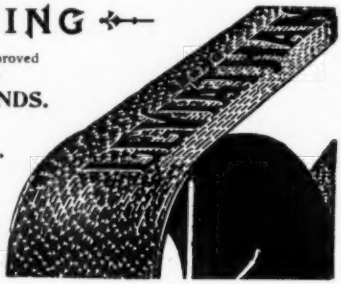

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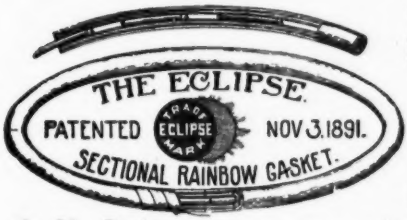

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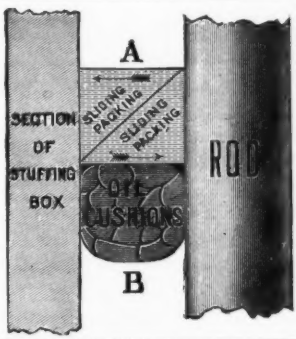

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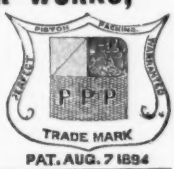

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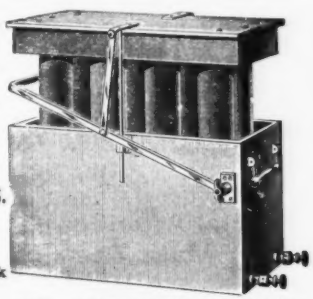

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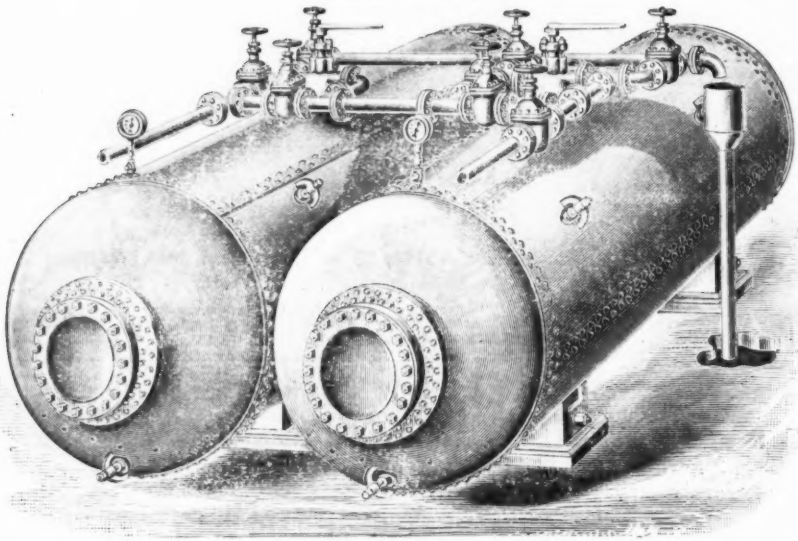

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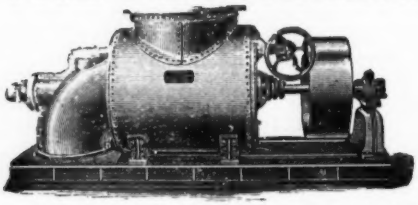

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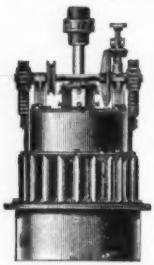

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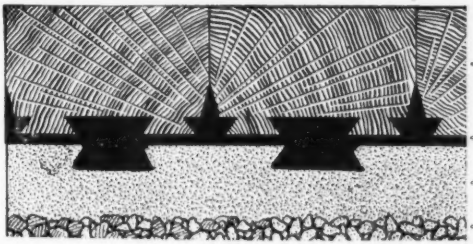

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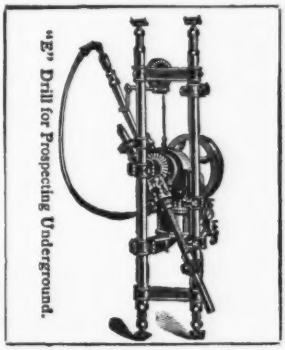

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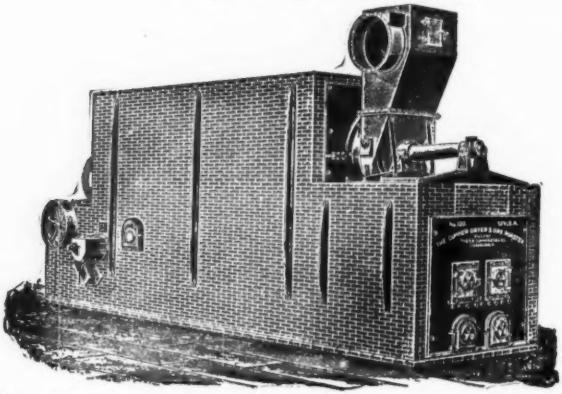

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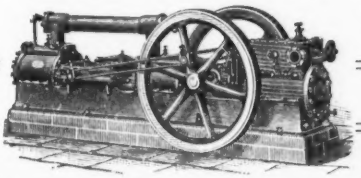

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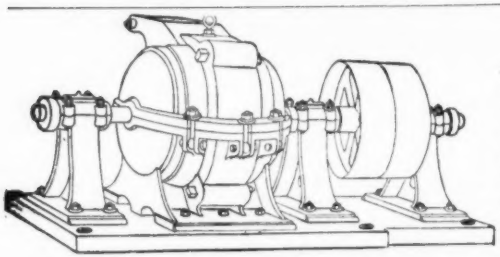

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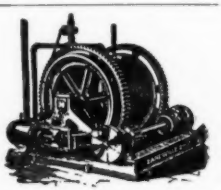

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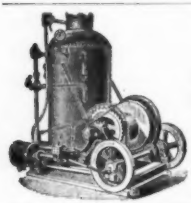

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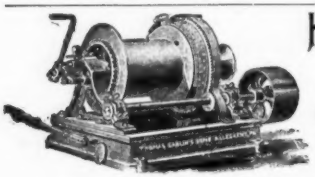

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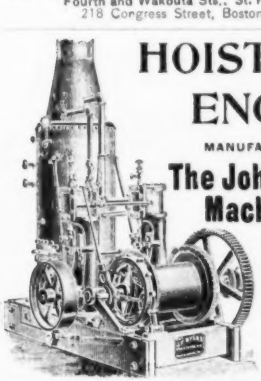

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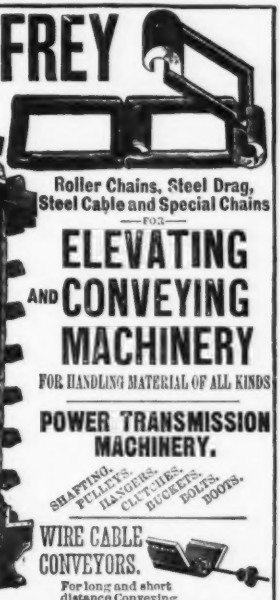

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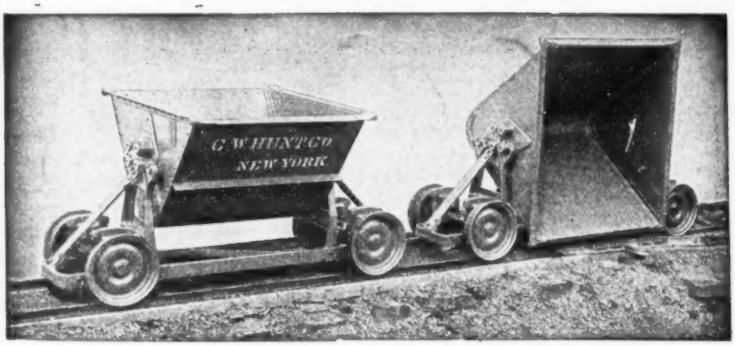

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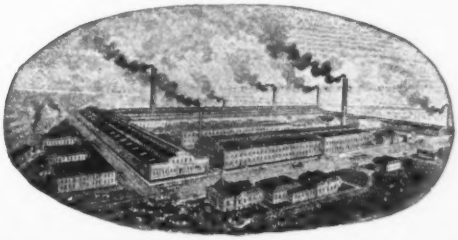

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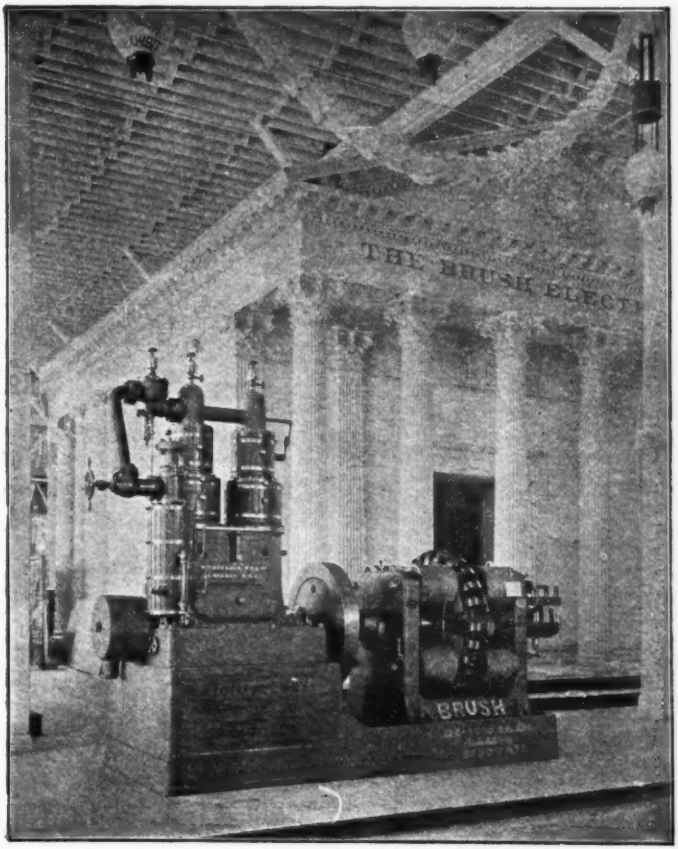

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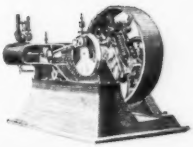

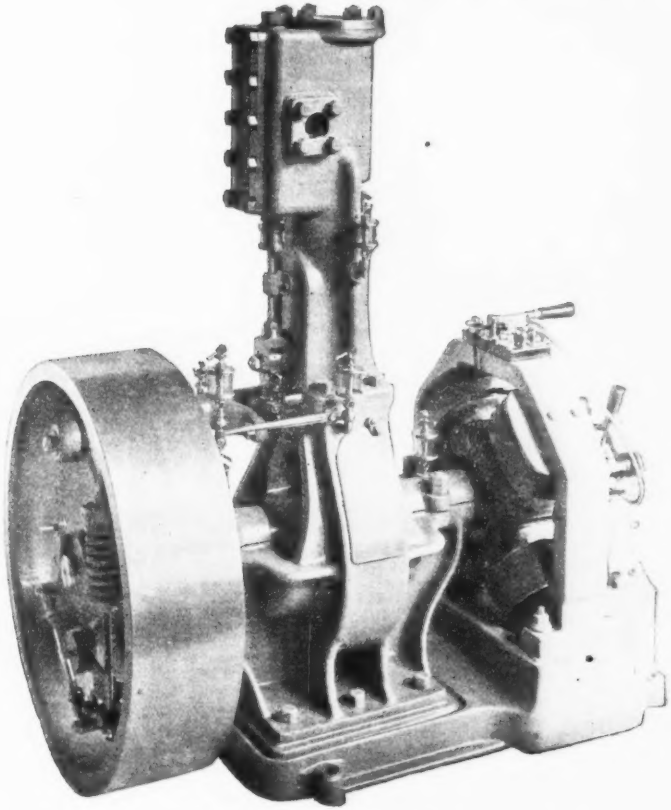

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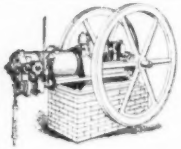

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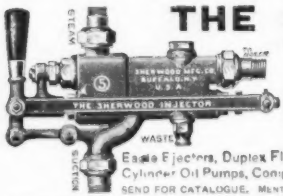

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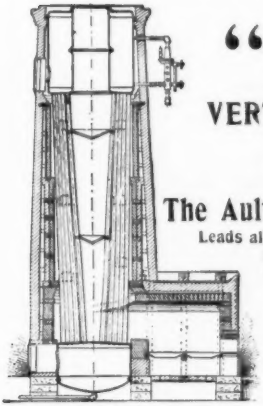

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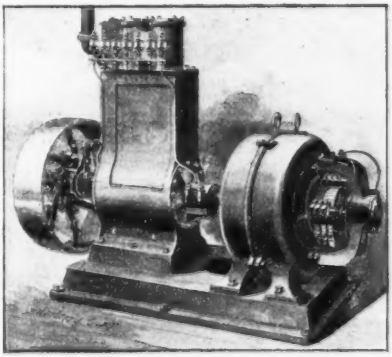

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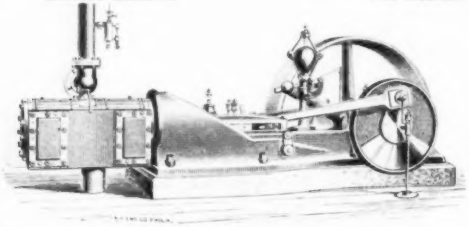

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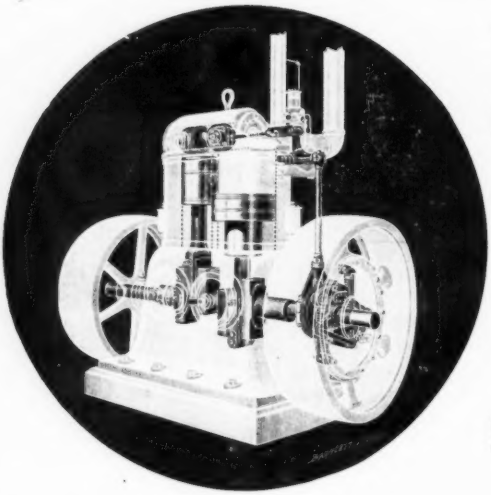

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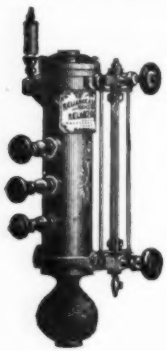

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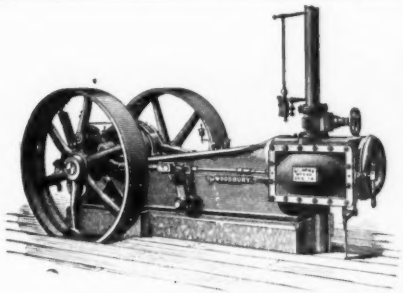

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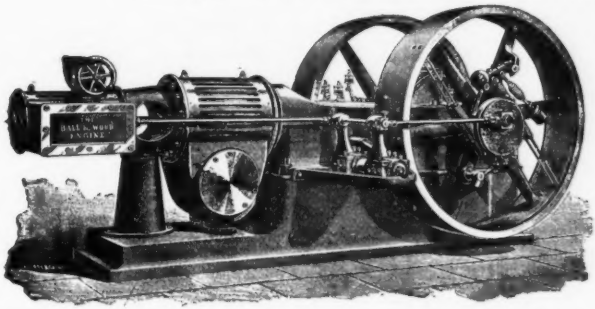

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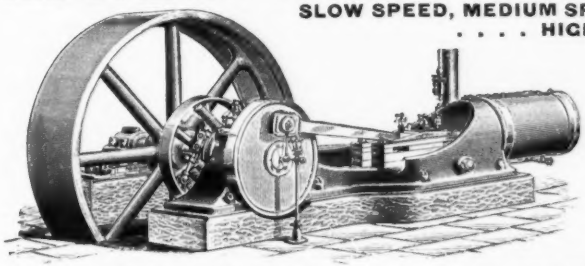

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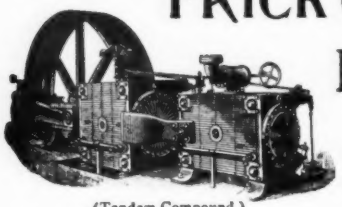

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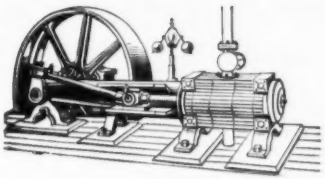

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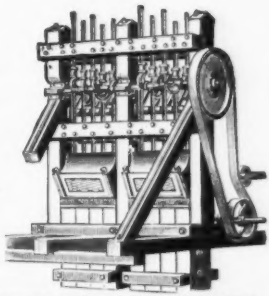

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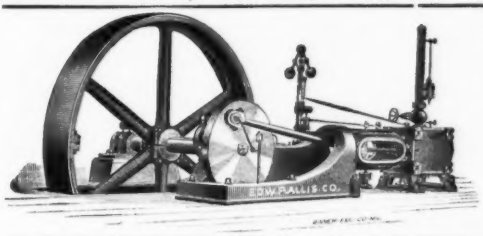

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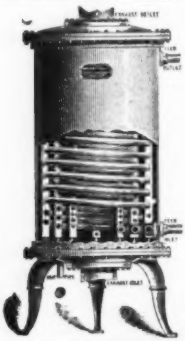

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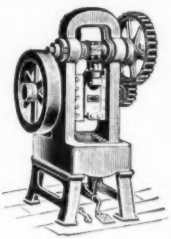

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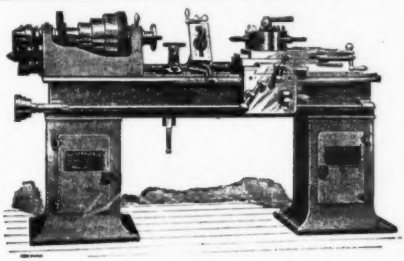

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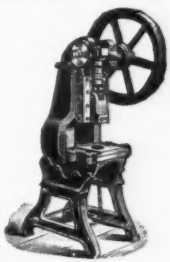

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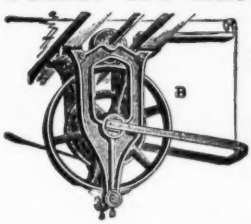

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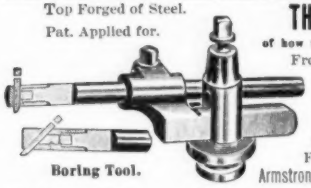

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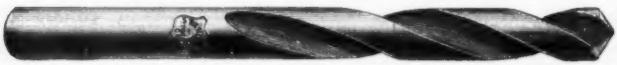

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Two	1½ " " " twelve " "	33
Ten	1 " "	32
Three	1 " " with six in. extra.	32
One	1 " " with dispatch brake	32
Three	½ " "	31
Four	½ " " six in. extra barrel	31

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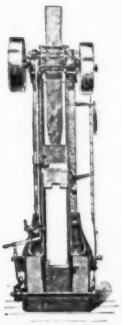

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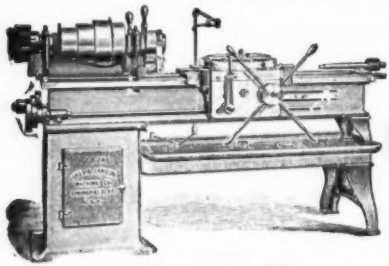

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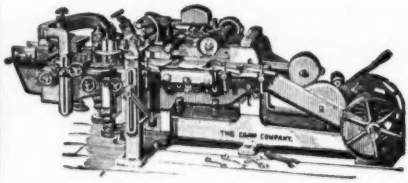

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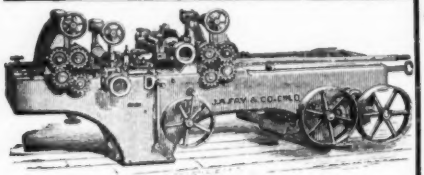

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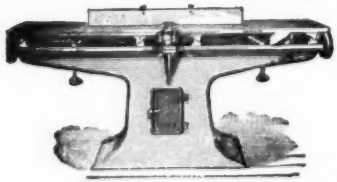

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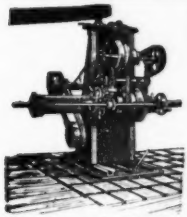

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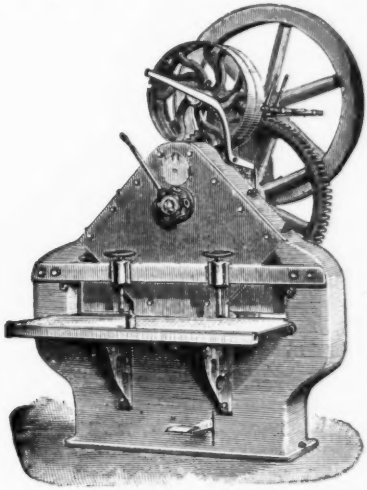

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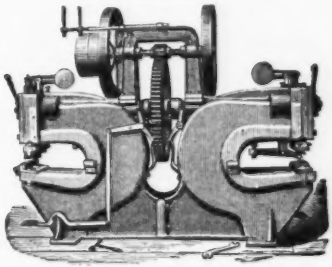

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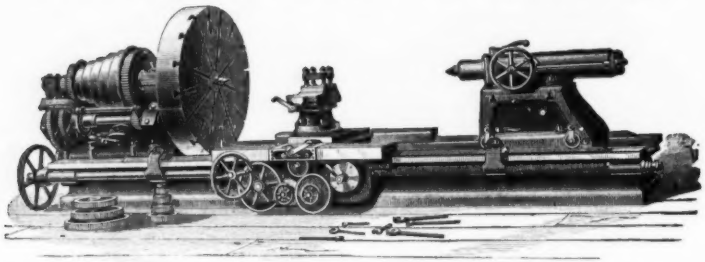

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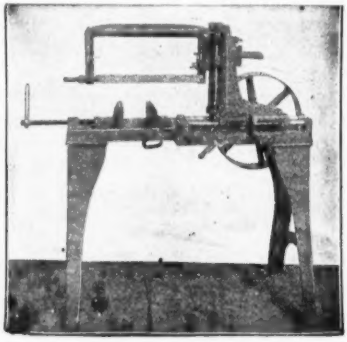

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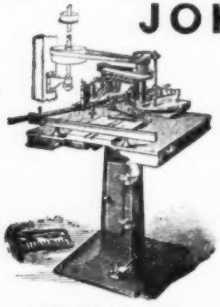

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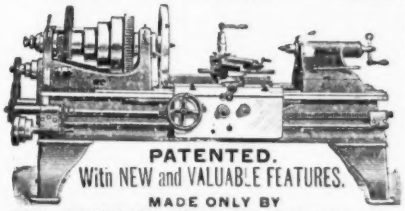

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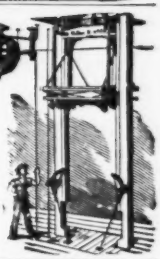

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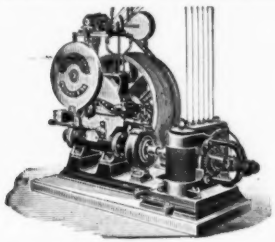

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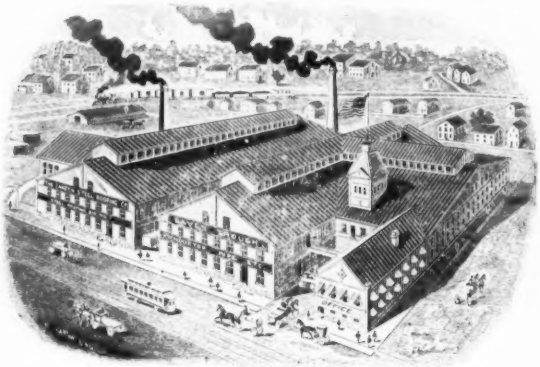

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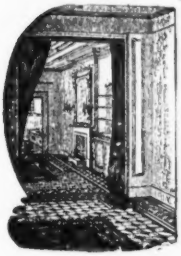

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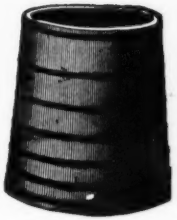

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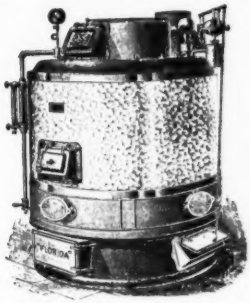

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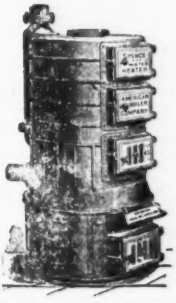

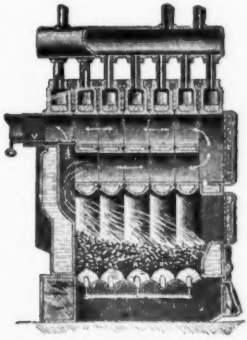

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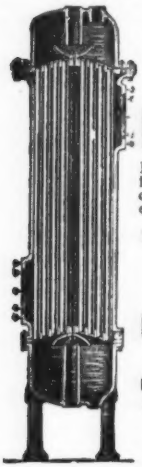

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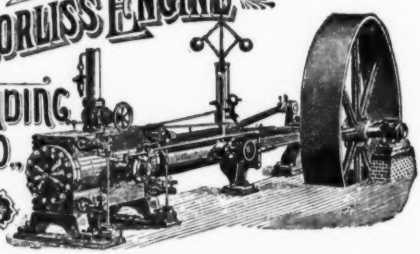

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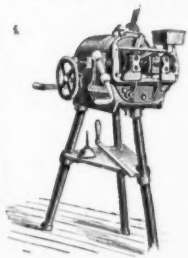

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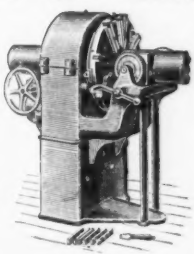

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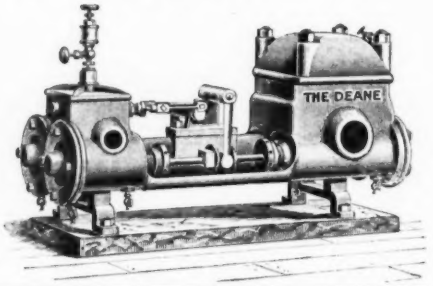

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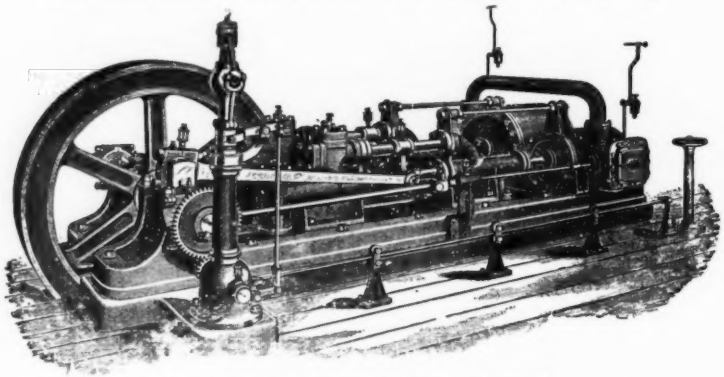

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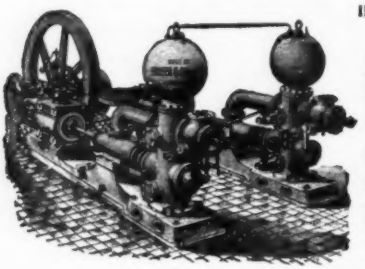

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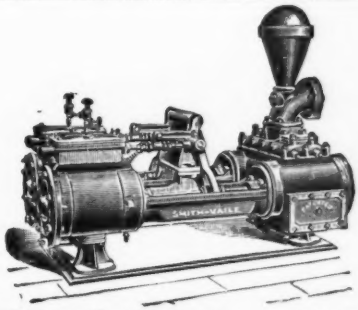

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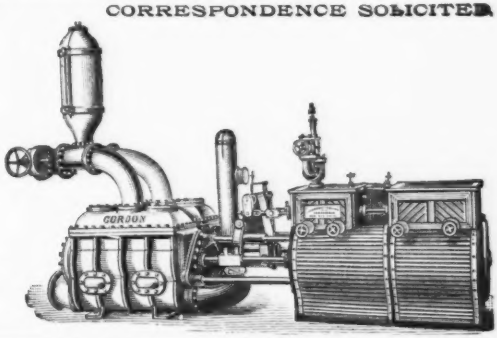

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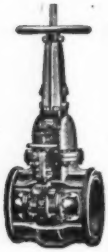

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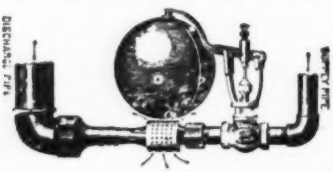

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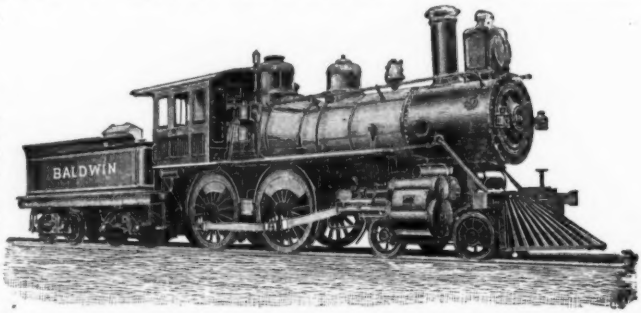

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DEAR SIRS:—Enclosed please find P. O. Order in payment of the six months' trial subscription, as per card, sent you some time back. The magazine more than fills the bill. Wishing you success. I remain, yours truly,

H. W. DAUCY,
No. 570 Commercial Street,
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Westinghouse Air-Brake Co.,

MANUFACTURERS OF

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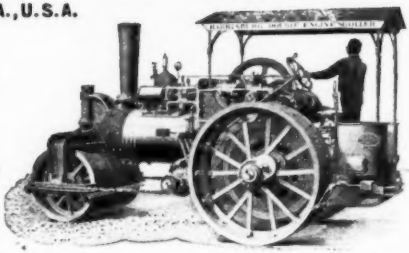

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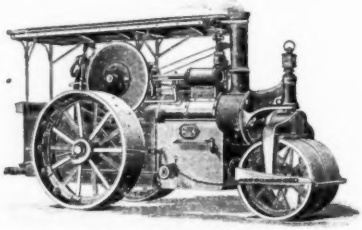


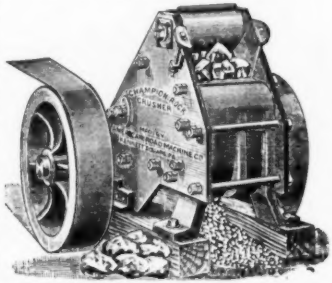
HANDSOME ILLUSTRATED CATALOGUE FREE ON APPLICATION.

Kind Words of Appreciation.

From *The Metal Worker*, New York.

This feature of the magazine (Review of the Industrial Press), will be much appreciated by those whose time is so limited that they cannot themselves scan the multitude of trade and technical papers that are issued every week.

Why not use the Best?



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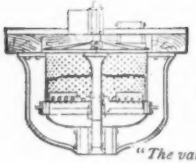

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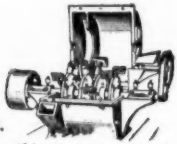


"The variety of kinds of material these machines will handle exceeds anything in my experience of thirty years of general grinding."

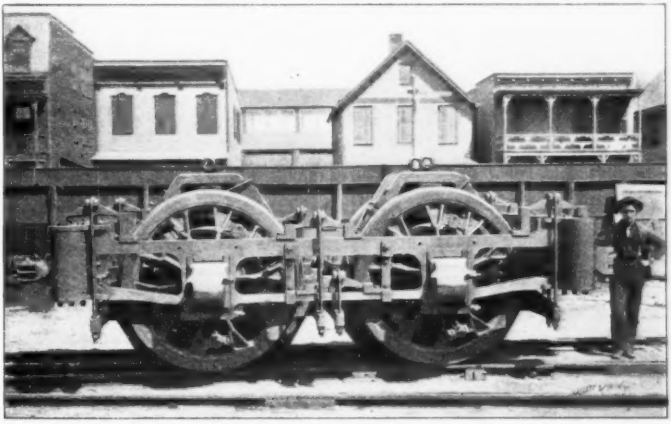
IMPROVED MACHINERY

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Electric Locomotives.

AN event for which electricians are waiting with impatient interest—the operation of passenger and freight trains on the Belt Line tunnel of the Baltimore and Ohio Railroad at Baltimore by locomotives in which the sole propulsive power will be electricity, is now nearing realization. Work has lately been progressing steadily at the works of the General Electric Company both upon the generating plant and the locomotives, and during the early part of this new year the huge locomotives will probably be handling the long trains with the ease for which they are designed. This experiment will be the first practical step in this country toward the subjection of the steam trunk railroad to electricity. Two comparatively small locomotives—one of thirty tons and the other of forty tons on the drivers—are already running, but not upon any important lines; while perfectly successful, their operation gives but little clue to the outcome of the practical tests on the Baltimore and Ohio Road. The delay that has occurred in the completion of the work has been of advantage as it has allowed of the embodiment in this apparatus of all the recent improvements in electric railway practice.

The trucks are of forged iron, each resting upon four driving wheels of cast steel, sixty-two inches in diameter. Flexibly supported upon each of these trucks are two, six-pole gearless, motors, one for each axle, transmitting their motion from the armatures to the wheels by means of an especially designed flexible coupling. The method of spring suspension has been carefully modified to allow of the immediate adjustment of the wheels to the irregularities of the tracks, and thus effect a diminution in the wear both to the motors and the track. The massive armatures are of the iron-clad type. A hollow shaft serves to carry the armature, and through this passes the wheel axle, to which it is connected by the universal coupling which allows of freedom of movement in any direction.



ELECTRIC LOCOMOTIVE TRUCK.

The complete motors are the largest railway motors in the world, and, while ponderous in appearance, are by no means so bulky as might be expected from the heavy duty they will be called upon to perform. They are so set on the truck that they will be easy of access under all circumstances, whether the locomotive is at a standstill or in motion.

The cab, which will be spring-supported on the truck frame, will be of sheet iron and wood, and will have windows on all sides in order that the occupants may have an unobstructed view in all directions. Within the cab will be set up the series parallel controller by means of which the movement of the locomotive will be at the command of the driver, and the air pump, operated by a small electric motor, which will supply the air for the compressed air brakes and the whistle. The locomotive will be also equipped with bells, safety devices, etc., and will have a Janney automatic coupler at each end.

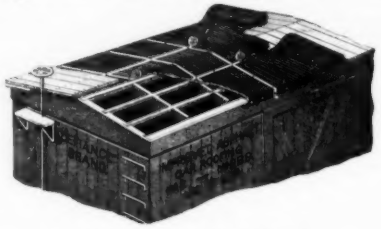
From the illustration of one truck it will be seen that the finished locomotive will be an imposing piece of electrical machinery. It will weigh, in its completed state, ninety-five tons, will be 14 feet 3 inches long, 9 feet 6¾ inches wide, and will be of standard gauge. The maximum speed will be 50 miles an hour. This will be reduced to 30 miles an hour when only half the draw-bar pull is exerted and to 15 miles an hour with full draw-bar pull. The average speed of the loaded train will be about 30 miles an hour. It can, of course, be run either forward or backward.

This locomotive is designed for heavy work, and will be called upon to handle trains as heavy as those now handled by the heaviest steam locomotives. A test of one of the completed trucks, —shown in the engraving—representing one half of the locomotive, was recently made upon the tracks at the Schenectady works of the construction company. In order to obtain the necessary load, a New York Central heavy six-wheel engine was made use of, and the electric locomotive truck coupled to it. The machines were then sent in opposite directions and tugged at the connecting coupling as in a tug of war. The electric locomotive had a slight advantage over the steam engine in weight on the driving wheels, and pulled it up and down the track with apparent ease. For the same weight upon the drivers it was shown that the electric locomotive will start a greater load than the steam locomotive, the pull being constant throughout the entire revolution of the wheel, and the difficulty of variation of pull with the angle crank as in the steam locomotive being eliminated. The test also proved that not only were the motors sufficiently powerful, but that the driving mechanism and armature couplings are amply strong to transmit the torque of the armature to the axle.

The power house is rapidly nearing completion and the generating machinery is almost ready for installation. The overhead apparatus, which has been especially designed to meet the extraordinary requirements, will shortly be in position, and before many months have passed the steam locomotive will have become neutral in the operation of trains in the Belt Line tunnel which, untarnished by smoke and soot, will be brilliantly lighted by incandescent lamps. A great step will have been made toward universal electrical locomotion on our steam roads.

Improved Asphalt Roofing.

FOR a long time there has been a very general and growing demand from Master Car Builders and other Constructors for an improvement in composition roofing offered for car service and other railway requirements. The A. E. Filley Mfg. Co. have been experimenting for a number of years to produce an improved roofing material to meet all requirements. This company claim to have achieved results in the tempering of asphalt which enables them to produce a composition roofing material superior to anything made in the past.



IMPROVED ASPHALT ROOFING.

This material is guaranteed to contain no coal tar, the destructive acids of which soon cause disintegration. Selected Refined Trinidad Asphalt is used in place of coal tar. The asphalt being tempered with an oxidized material, which is not soluble in water, but is soluble in asphalt and united with it, forms a perfect chemical combination, the result being a product which is claimed to remain flexible in a freezing temperature and also resist a very high heat temperature without materially softening. Heretofore all mixers of asphalt have been

obliged to use petroleum residuum for tempering. As petroleum residuum is soluble in water and not soluble in asphalt, the result of its use as a tempering agent for asphalt, means a mechanical mixture and not a chemical combination. The products of this company are guaranteed to contain no petroleum residuum. Felt is easily torn or mutilated, even when several sheets are run together; therefore this company has adopted heavy burlap as the base or foundation of their roofing. The burlap is thoroughly saturated and heavily coated with the tempered asphalt. Before the asphalt is thoroughly cold, the material is passed through heavy pressure rolls. The result is claimed to be a compact, heavy sheet of material, flexible, elastic and of great tensile strength, thoroughly and absolutely waterproof, containing no volatile substance, not affected by the atmosphere or the action of acids, gases, etc., particularly the sulphureous gases from the use of coal.

These qualities particularly adapt the material for railway uses. The company manufacture several grades, containing from one to three webs of burlap, which are offered for roofing freight cars. The method of applying this material to freight cars is illustrated in the cut herewith. The material is known as "Defiance" Improved Asphalt Car Roofing. It is also well adapted for street car roofs, stair pads, steamboat decks, damp course, etc., etc., and for general roofing purposes. The company also manufacture two grades of roofing surface coated with granulated iron slag, known as "Improved Asphalt Slag Roofing," adapted for all railway buildings. The granulated slag on the surface makes it in effect a flexible, iron surfaced fireproof roof, as cinders, sparks, embers, etc., do not affect it.

The company have many letters speaking in very high terms of their material, at their offices 39 & 41 Cortlandt St., New York City.

Bucyrus Steam Shovel and Dredge Co.

SOUTH MILWAUKEE, WIS., Jan. 28th, 1895.

To whom it may concern:

The undersigned have to-day been appointed Receivers of the Bucyrus Steam Shovel and Dredge Company, and, as such, have taken possession of all property, assets and business of the company. You are hereby notified that all payments should be made to us.

Under the orders of the Court, the business of the company will be prosecuted as usual. Existing contracts will be executed, unless notice to the contrary shall be given, and orders for new machinery, repairs, supplies, etc., will be received on behalf of the Receivers and promptly attended to.

All supplies and material which may come in subsequent to this date, will be for account of the Receivers. Soliciting your continued patronage, we are,

Very respectfully yours,

JOHN S. GEORGE,
HOWARD P. EELLS,
Receivers.

A Superior Line of Garden Hose.

THE goods offered by the New York Belting & Packing Co., Ltd., at No. 15 Park Row, New York City, in this line, for the ensuing year are especially attractive in quality and workmanship. All this company's hose is machine-made, and has seamless tubes, insuring evenness and uniformity in construction, compactness and extreme durability. Of rubber-lawn hose, the brand "1846 Para" ranks with the best in the market. It has been manufactured for nearly fifty years, from the finest quality of Para rubber and cotton duck.

The "Double Diamond," is a strong and durable hose, constructed of excellent stock, and ranks next to "1846 Para." The "Carbon" and "Spider" brands are cheaper and popular grades.

The "Double Diamond" is a cotton lawn hose. The best long staple cotton, heavily and closely woven, is used in the manufacture of this brand, which is capable of sustaining a hydraulic pressure of over 500 pounds to the square inch. A special feature is the seamless rubber tube, which, being perfectly smooth, prevents friction while water is passing through. Every section of this hose bears the name of the manufacturers on a rubber label. The cotton lawn hose possesses strength and durability, and will stand the pressure of any water works system. By a special treatment termed "Leatherite" a positively rot-proof cotton hose is produced. This hose is similar to the "Double Diamond," though not so heavy, possessing all its attractive qualities and in addition being mildew-proof. A change of weave has been made in the covers since last year, which increases its strength and durability.

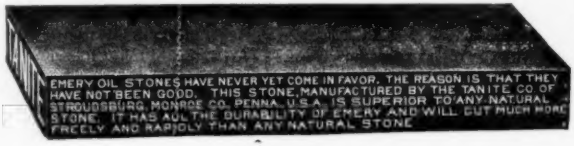
The company will furnish all brands of its

arden hose, wire wound or armored for heavy pressure when desired. Branch pipes, hose-reels and sprinklers, are also kept in full line by this company. The wire armor affords protection against abrasion and other injury.

The Tanite Whetstone.

WHILE the grind stone still remains, and possibly always will remain a popular and useful tool in the manufacture of iron and steel goods, the mechanical public were quick to see the value of an artificial wheel whose emery grains were harder and sharper than those of natural and sometimes rounded sand. Hence the solid emery wheel soon made its way into public favor. It seems strange that a similar material and process was not at the same time successfully applied to the production of honestones, oil stones and whetstones. Early attempts were made to introduce such articles, but, for various reasons, failed. The peculiar properties of Tanite, which fit it for a base in emery wheel manufacture, have been applied by The Tanite Co., of Stroudsburg, Pa., U. S. A., to the production of Solid Emery Whetstones. The result has been a great practical success, though the prejudice of the trade and the novelty of the article have conspired to make the demand irregular and scattering. That this state of the trade is not due to the quality of the artificial whetstone is evidenced by the fact that in quarters where it has once been introduced the demand is regular.

The Tanite Whetstone is adapted to the mill pick, the carpenter's and stone cutter's chisel, the bit of the moulding mill and the axe of the woodman.


EMERY OIL STONES HAVE NEVER YET COME IN FAVOR. THE REASON IS THAT THEY HAVE NOT BEEN GOOD. THIS STONE, MANUFACTURED BY THE TANITE CO OF STROUDSBURG, MONROE CO. PENNA. U.S.A. IS SUPERIOR TO ANY NATURAL STONE. IT HAS ALL THE DURABILITY OF EMERY AND WILL CUT MUCH MORE FREELY AND RAPIDLY THAN ANY NATURAL STONE

THE TANITE WHETSTONE.

Mr. A. G. Sinclair, late President of The New York Emery Co., has connected himself with The Tanite Co. Mr. Sinclair is one of the oldest salesmen in the Emery trade, and also a practical manufacturer of Emery.

NEW TRADE CATALOGUES.

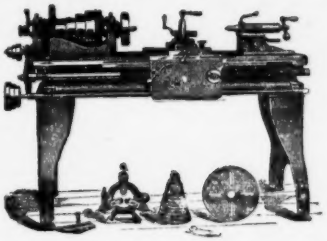
Fraser & Chalmers, Chicago, Ill., U. S. A., and London. (1)=Catalogue No. 1, 3d Edition, Code word "Asperse." 84 pp., 9″ × 6″. [Steam engines and boilers, power plants and steam machinery. Describes and illustrates vertical and horizontal Corliss, and four cylinder triple expansion Wallace engines, with details of valve gear, &c., "Tangye" stationary engine, "Lively Detached" portable engine and boiler, horizontal tubular boilers with arch and full fronts, Hazelton sectional tripod boiler, upright tubular boilers, water jacket condensers, surface condensers, steam jackets, feed water heaters and purifiers, plane tubular heaters, mechanical stokers, &c., with code list.]

(2) Catalogue No. 2, 1st edition, code word "Aspersion." 80 pp., 9″ × 6″. [Describes and illustrates hoisting engines and appliances with engravings of complete hoisting plants; direct acting double reel hoists; hoisting engines with Corliss valve gear; direct acting double reel hoists with piston valve engines, brakes, reversing gear and jaw clutches, direct acting drum hoists, geared hoisting engines with reels for flat rope and with drums for round rope, and description of their general construction; double cylinder link-motion hoisting engines; combined friction drum and brake and reversible link motion hoisting engines, specially adapted for mines, inclines, &c., double drum reversing link motion hoisting engines, cotton rope drives for cable railroads, &c., &c., with code list.]

(3) Catalogue No. 9, 3d Edition, Code word "Aspettone." Concentration machinery. 62 pp., 9″ × 6″. [Describing and illustrating a full line of machinery for coarse and fine concentration, including picking tables, elevators, crushing rolls, sand wheels, screens, hydraulic separators, settling boxes, Frue vanners, Embrey concentrators, buddles, Rittinger tables, &c., together with a partial list of sales, and important code words.]

(4) Catalogue No. 13, 2d Edition, Code word "Asphaltum." The Frue Vanner. 72 pp., 9″ × 6″, with folder plate. [The folder plate displays the full details of the improved Frue vanner and the text of the book describes the machine with full directions for setting up and operation, and also describes the Embrey concentrator, with its construction and use. A description of the vanning plaque for hand concentration, and 16 pp. of testimonials, with a directory of parties to whom this firm has supplied mining machinery, complete the catalogue.]

Prentiss Tool and Supply Co.



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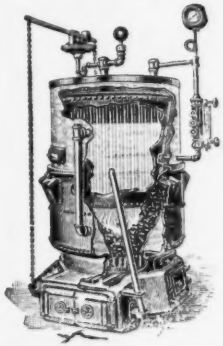

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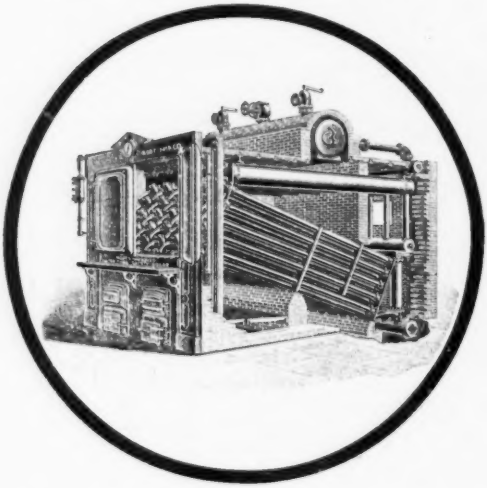

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